America's First Aeronautical Magazine

AVIATION

UNE 1946
O CENTS PER COPY

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SIMPLIFIED DESIGN OR PERSONAL PLANES

alph Upson begins a and vital series on eryday problems in ilaing better planes, esenting practical orking formulas to peed and ease the de- igner's work.

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rst complete article, ith engineering draw- gs, covering design d flight characteris- of Nazi's most ad- ed rotary wing aft.

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WHAT WILL HAPPEN AT BIKINI?

earching preview of plans d expectations of Opera- ons Crossroads as seen from e aeronautical standpoint.

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T'S A SOUND INDUSTRY

ur Financial Editor's annual rvey — with its reference- ork table of annual report gures — shows the current liar-wise position of aircraft anufacturing companies.

★

GETTING RID OF STATIC

w techniques for keeping dios interference-free when ey're most needed are re- ealed in our Aviation Elec- onics section.

McGRAW-HILL
PUBLISHING COMPANY, INC.

AVIATION

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Volume 45 • No. 6

McGRAW-HILL PUBLISHING CO., Inc. Publishing office 99-129 North Broadway, Albany 1, N. Y. Return postage guaranteed. Editorial and executive offices: 330 West 42nd Street, New York 18, N. Y. Branch offices: Chicago, 520 North Michigan Ave.; San Francisco, 68 Post Street; Aldwych House, Aldwych, London, W.C. 2; National Press Bldg., Washington; 16 South Broad St., Philadelphia; Hanna Bldg., Cleveland; 2980 Penobscot Bldg., Detroit; Continental Bldg., St. Louis; 1427 Statler Bldg., Boston; Rhodes-Haverty Bldg., Atlanta; 621 S. Hope, Los Angeles; 738-9 Oliver Bldg., Pittsburgh. JAMES H. McGRAW, Founder and Honorary Chairman; JAMES H. McGRAW, Jr., President; CURTIS W. McGRAW, Senior Vice President and Treasurer; JOSEPH A. GERARDI, Secretary; NELSON BOND, Director of Advertising; EUGENE DUFFIELD, Editorial Assistant to the President; J. E. BLACKBURN, JR., Director of Circulation. Aviation, 330 W. 42nd Street, New York. Published monthly, price 50¢ a copy, 50¢ in Canada. Allow at least ten days for change of address. All communications about subscriptions should be addressed to Director of Circulation, 330 West 42nd Street, New York. Subscription rates—United States and possessions, $3.00 a year, $4.00 for two years, $5.00 for three years. Canada, $4.00 for one year, $6.00 for two years, $8.00 for three years, payable in Canadian currency at par. Pan American countries, $4.00 for one year, $10.00 for two years, $12.00 for three years. All other countries, $15.00 a year, $30.00 for three years. Please indicate position and company connection on all subscription orders. Entered as second class matter September 3, 1936, at the Post Office, Albany, N. Y., under the Act of March 3, 1879. Volume 45, Number 6. Printed in U. S. A. Cable Address "McGrawhill, New York." Member A.B.C. Copyright 1946 all rights reserved by McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York, N. Y. The contents of this issue may not be reproduced without the permission of the copyright owner. The following publication is combined with AVIATION: AERONAUTICAL ENGINEERING, AIRCRAFT JOURNAL. All rights to this name are reserved by the McGraw-Hill Publishing Co. Aviation is indexed in Readers' Guide to Periodical Literature and in Industrial Arts Index.

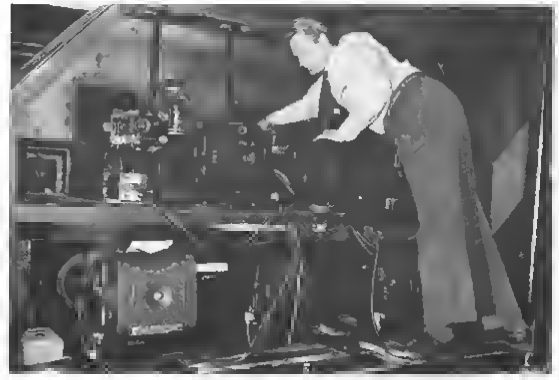
Just a year ago this month we started what we believed to be "one of the most important and valuable aircraft design presentations it has ever been our pleasure to present"—meaning Ralph Upson's series, "Designing Tomorrow's Personal Airplane." The reception accorded these special articles proved our belief—and generated a demand for more.

So, beginning on page 55 of this issue we take just as much pride in presenting the first of a new Upson series—"Simplifying Personal Plane Design." In these articles, Mr. Upson will cover the problems of "proportioning and degree," those tough ones which often present hard-to-make choices in such vital factors as performance, range, wing loading, aspect ratio, stability and control, and landing and takeoff characteristics. And, to make it absolutely complete, he will present each month sound, practical formulas—some never published before—which can be used as everyday tools to solve the problems of design work.

It wasn't till after VE-Day that the Allies could find out what progress—if any—the Germans had made with helicopters. It was then learned that they hadn't been neglecting rotary wing craft, as is shown by the Flettner Fell 282, their most advanced job and the one which had been extensively flight tested, including operations in gusty winds and blind flying. Just how far along the Nazis were is shown in our detailed article on the Fl 282 (beginning on page 60) which delves into not only the craft's engineering features but its flight characteristics as well.

The turbojet boys are still at it—something new every month. This time we give the details on the Metropolitan Vickers F/3 an axial flow job with thrust augmentation that gets specific fuel consumption down to 0.65. It's a most intriguing design—2-stage turbine driving the compressor and two 2-stage contra-rotating turbines driving two contra-rotating fans for the thrust augmentation. This article is on pages 66 and 67.

We're more than a little proud to announce a change in our radio section. Now that it's possible to give some of the necessary details, we are broadening this section to embrace all angles under the head, Aviation Electronics (page 52). Here, the month's outstanding developments will get regular space. To assure the best and most accurate coverage, we have arranged to have the section conducted by Frank Rackett, Associate Editor of McGraw-Hill's leader in the field, "Electronics."



THIS SHIELD FITTED BATTERY of Fairchild cameras—along with many others—will be radio-controlled to record the forthcoming atom bomb test at Bikini Atoll. Properly called one of the most far-reaching experiments ever conducted by man this A-bomb test is predicated upon aviation, and it will be highly influential in charting the future course of military aeronautics. To give you a complete picture of the aviation aspects of this transcendental event, Associate Editor Herb Powell has prepared (page 38) a penetrating preview of the highly complex and fascinating plans for Operation Crossroads. (Press Assn. photo)

Down the Years in AVIATION'S Log

25 Yr. Ago (1921)—Ralph Upson wins National Balloon Race traveling 425 mi. ... Navy bombs warships in test ... Berl Hathaway of U. of Cal. is first college student to fly to classes ... Army organizes 1st Provisional Air Brigade combining all flying branches ... Dornier builds DoCS-II, cabin flying boat ... Two Navy HS-2L flying boats ride out heavy storm at anchor for two days ... Dayton-Wright wins Navy award of $10,000 for shipboard aircraft design ... There are now 31 aircraft manufacturers with 250% increase in business during last year.

15 Yr. Ago (1931)—Twenty-six airlines carried 11,504 passengers in month ... James G. Ray lands autogiro on White House lawn. ... French air budget is $88,000,000 for year. ... Junkers develops commercial aircraft Diesel engine. ... Legislation calls for Board of Health inspection of planes flying from plague-harboring countries. ... Japanese-built dirigible makes endurance record of 60 hr. without refueling. ... Army consolidates all Air Corps schools at Randolph Field. ... French Pilots Froton and Lavergne fly lightplane 2,453 mi. in 29 hr. 38 min., breaking record. ... Navy orders 30 Helldivers from Curtiss for $440,000.

10 Yr. Ago (1936)—Langley Field installs 500 mph. wind tunnel. ... Coffee manufacturer uses Bellanca Airbus for regular deliveries to distant points. ... Navy experiments with oxygen for high flying pilots. ... Zeppelin Hindenburg completes first non-stop trans-Atlantic trip to Lakehurst. ... Air express volume goes up 58% in year. ... C&S specifies Lockheed Electras for its services. ... Taylorcraft places first model on market. ... Stinson reports $1¾ million business for current year. ... Congress passes Naval appropriation of $27,000,000.

The New Cessna Features Cross Country Performance with Scout Instruments by Kollsman

The Cessna instrument panel with complete instrumentation and radio

The new all-metal Cessnas — with their four and one-half hour cruising range and super-comfortable cabin appointments invite cross country enthusiasts. The allure is made complete by the featuring of famous Kollsman Scout flight instruments as standard. For it is the accuracy and dependability of such instruments that makes cross country flying practical and enjoyable

The new Cessnas are equipped with an indirectly lighted, shock-mounted instrument panel bearing the Scout airspeed indicator and Scout standard altimeter as standard equipment and with the Scout sensitive altimeter and Scout vertical speed indicator optional. The latter two, as well as a turn and bank indicator, can be added to the basic group at any time

Scout instruments are getting more than one post-war plane off to a good start. They are precise and rugged, yet are priced within the reach of any private plane owner who wants to get the most out of his plane.

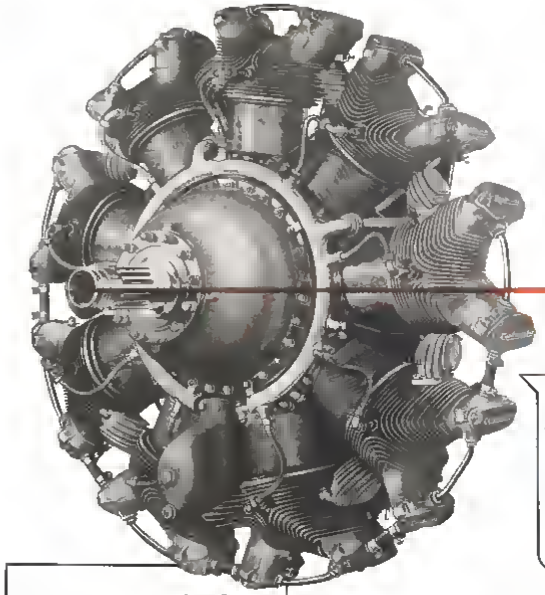
Write today for complete information on these instruments to Kollsman Instrument Division, Square D Company, 80-08 45th Avenue, Elmhurst, N. Y.

KOLLSMAN AIRCRAFT INSTRUMENTS

PRODUCT OF

SQUARE D COMPANY

ELMHURST, NEW YORK GLENDALE, CALIFORNIA



The New Continental GR-9A

9-cylinder Radial Engine for Feeder-line and Executive Type Aircraft

POWER BY Red Seal Engines CONTINENTAL

These Continental Refinements Mean Greater Power, Economy and Dependability, as well as Longer Life:

- Increased cooling fin area on cylinder heads and barrels.
- Enlarged supercharger impeller and re-designed supercherger entrance and diffuser passages.
- Complete force-feed lubrication to valve gear.
- Propeller reduction gear (on GR-9A model).
- Crankshaft has been re-designed and is nitrided.
- New pressure-type (injector) carburetor.
- New "Silver grid" crankpin bearings.
- Improved generator drive.
- Flexible engine mounting pads.
- Enlarged oil passages to crankshaft.
- Oil pump completely re-designed for greater capacity.
- All main castings re-designed for higher loading.

SKYPOWER FOR THE AGE OF AIR

More than 44 years of specialized experience, enriched by intensified research throughout the war years is noteworthy climax in the new R-9A Aircraft Engine which Continental Motors has recently introduced.

The O-9A, and its geared counterpart, the GR-9A, are basically identical with the famous Continental-built radial aircraft type engine which powered some 54,000 medium tanks and Hellcat tank destroyers in World War II. As now offered for aircraft they are special-purpose engines, developed primarily for the planes for feeder line and executive use, now coming off assembly lines in major aircraft plants. In them are embodied numerous refinements, covering the fields not only of design and materials, but of production techniques. These advances, proven by millions of hours of operation in aircraft and tanks, result in greater power—525 h.p. in the O-9A and 600 h.p. in the GR-9A—and in increased reliability and economy as well.

In feeder-line applications, where such special performance characteristics as short take-off and fast climb are paramount, and where these surpluses must be gained without compromise on the score of dependability, these new Continental Aircraft Engines are the answer to a great and growing need. A brochure describing the Continental R-9A and GR-9A is in preparation and will be mailed on request.

Continental Motors Corporation

DETROIT AND MUSKEGON, MICHIGAN

500...COMING UP!

★ **THE BELL MODEL 47B HELICOPTER**—*powered by a six cylinder Franklin Aircooled Engine of 175 H P—has a gross weight of 2100 pounds, including a useful load of over 600 pounds It utilizes a patented two-bladed rotor and gyroscopic stabilizer The Model 47B is noted for smoothness of flight and ease of control* ★

FIRST Helicopter in history to be awarded a commercial license, Bell Aircraft's two-place Model 47B is now being put into quantity production. Initial deliveries from the first 500... to government agencies, industry and agriculture...scheduled for early Fall.

This remarkable rotary wing craft offers a new kind of *all-weather* utility. The Bell Helicopter needs no airports, no costly pavements or other landing facilities It can reach hitherto inaccessible places. And it can land safely in "auto-rotation".

For full facts about the Model 47B Helicopter—performance, operation, utility—simply write. Helicopter Division of Bell Aircraft Corporation, Box One, Buffalo 5, New York

BELL HELICOPTER FIRST IN FLEETOBY TO RECEIVE COMMERCIAL LICENSE

On March 8, 1946, Bell Aircraft received a CAA Airworthiness Certificate on its two-place Model 47 helicopter, and CAA license number NC 1H, *the first helicopter "NC" license ever issued.* These certificates were issued after exhaustive flight tests in which the Model 47 prototype of the Model 47B met every airworthiness requirement of the CAA.

THE MODERN MAGIC CARPET*

*Reg. applied for U.S. and principal foreign countries.

BELL *Aircraft* **CORPORATION**

© Bell Aircraft Corporation

P. O. Box 1, Buffalo 5, New York

PACEMAKER OF AVIATION PROGRESS

THE GEAR DESIGNER SAID:

"I choose alloys like I chose my wife . . .

because a lifetime is a long time!"

AN odd way to put it perhaps, but the meaning is clear. Any manufacturer who produces machine parts for transportation products knows that he's going to have to "live with" the performance of those parts for the life of the product. When a man buys an automobile or an airplane, he expects the gears and bearings to last as long as the product itself. If they don't, it's a black eye for the manufacturer.

We can help you meet the expectations of your customers and still keep your manufacturing costs in line. Our U-S-S Carilloy specialists make it their business to have at their fingertips the very latest information on the application of alloy steels in the automotive and aviation industries. If you want to reduce weight and at the same time increase resistance to wear, fatigue and shock, our metallurgists can show you how the right alloy steel can be applied to accomplish your objective economically.

U-S-S Carilloy Steels represent your most complete source of high quality alloy steels, now available in all grades, finishes and treatments and in the widest range of forms and sizes found anywhere. A letter from you will bring one of our specialists to your plant, ready to put our metallurgical and production facilities at your disposal.

LISTEN to the United States Steel radio show every Sunday evening. Consult your local newspaper for time and station.

U·S·S Carilloy Steels

ALLOY STEELS FOR THE SPECIAL JOBS OF INDUSTRY

CARNEGIE-ILLINOIS STEEL CORPORATION

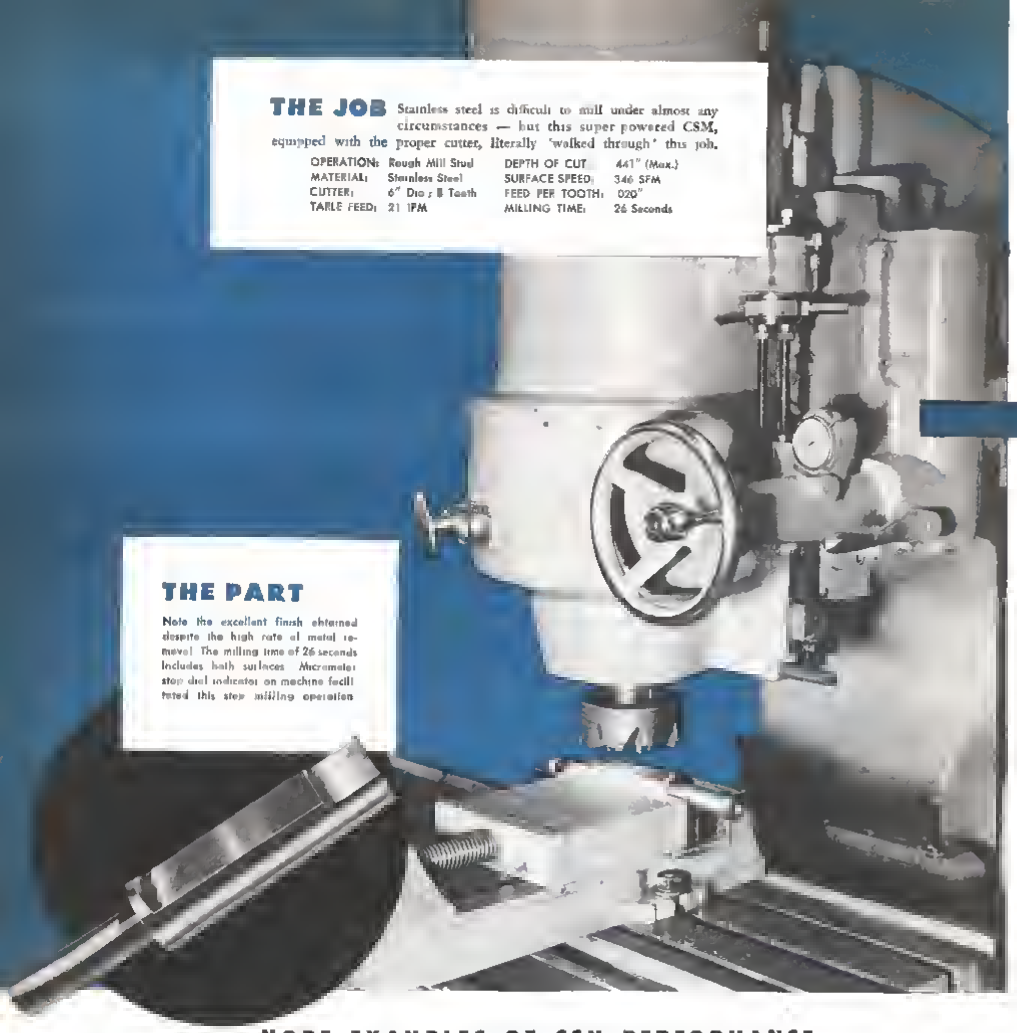
Pittsburgh and Chicago

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
Tennessee Coal Iron & Railroad Company, Birmingham, *Southern Distributors*
United States Steel Export Company, New York

UNITED STATES STEEL

STAINLESS STEEL MILLING

made easy on a KEARNEY & TRECKER CSM



THE JOB Stainless steel is difficult to mill under almost any circumstances — but this super powered CSM, equipped with the proper cutter, literally 'walked through' this job.

OPERATION:	Rough Mill Stud	DEPTH OF CUT:	.441" (Max.)
MATERIAL:	Stainless Steel	SURFACE SPEED:	346 SFM
CUTTER:	6" Dia. x 8 Teeth	FEED PER TOOTH:	.020"
TABLE FEED:	21 IPM	MILLING TIME:	26 Seconds

THE PART

Note the excellent finish obtained despite the high rate of metal removal. The milling time of 26 seconds includes both surfaces. Micrometer stop dial indicator on machine facilitated this step milling operation.

MORE EXAMPLES OF CSM PERFORMANCE

Operation: Rough mill angle on knee elk support—with 34% time reduction. Material: C 1—Speed: 336 sfm—Cutter: 3" dia., 8 T—Feed per tooth .010"—Depth of Cut: 5/32". Previous Milling time: 61 seconds — CSM Milling time: 45 seconds.

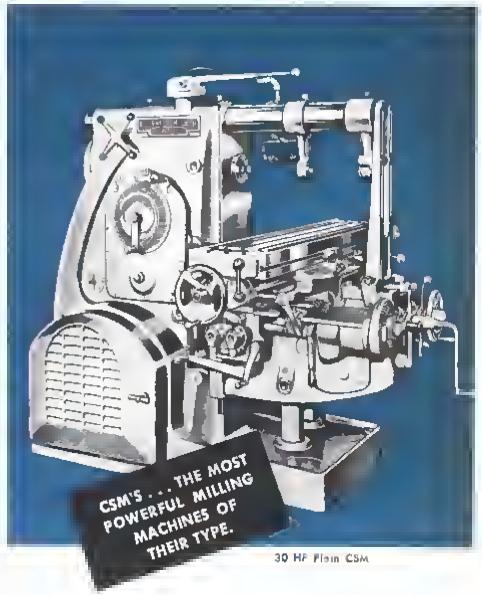
Two views of set up for milling socket arm port with 65% milling time reduction. Center shows rear of special holding fixture in place on machine table. At right machined surfaces of part. Material: Cast Steel—Surface Speed: 346 sfm—Cutter: 6" dia. 8 Teeth—Feed per tooth: .012 —Depth of cut ¼". Previous milling times: 4 min. 52 seconds—CSM milling times: 1 min. 42 sec.

CSM Milling Machines were designed to obtain the greatest benefits from modern cutting tools, and are now part of our line of standard models. The design has been stabilized after complete analysis of industry's problems of milling with carbide cutters.

Because they are knee type machines, they are readily adaptable to a great variety of work. They are precision built in accordance with long established Kearney & Trecker standards and will cut metals faster and to finer tolerances and superior finishes than ever before — with high speed steel cutters as well as carbide cutters.

CSM machines are available in 20, 30 or 50 H.P. models in both plain and vertical knee types.

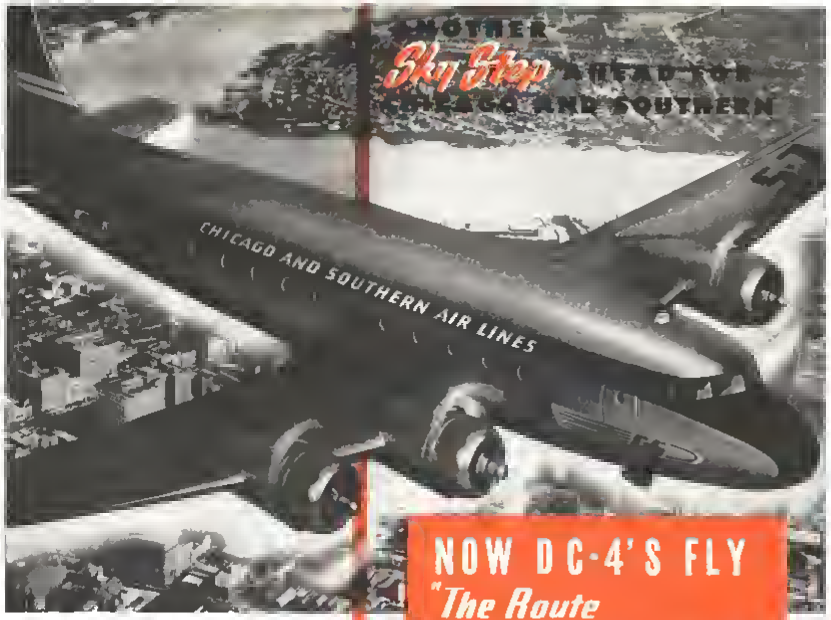
Write for complete data on CSM machines — CATALOG CSM-20. Please indicate your business connection.



30 HP Plain CSM

KEARNEY & TRECKER CORPORATION
MILWAUKEE 14, WISCONSIN

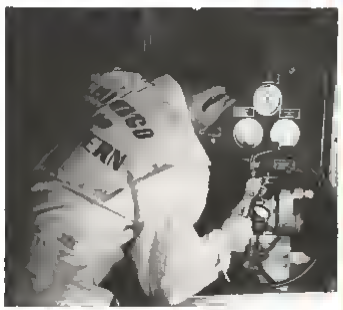
"Be ready for tomorrow with CSM's"



NOW DC-4'S FLY "The Route of the Dixieliners"

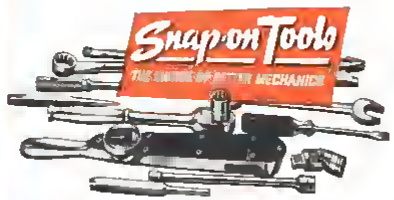
"Sky Steppers" is the name that the army of friendly, hard-working, sure flying employees of Chicago and Southern are proud to call themselves Soundly and aggressively this organization has "sky stepped" from modest beginnings to top place as the major Gulf-to-Great Lakes airline Now a fleet of DC-4's joins the Dixieliners; inaugurating a new era of surpassingly swift and luxurious flight between Chicago and New Orleans, between Detroit and Houston

Back of Chicago and Southern's distinguished safety record is conspicuous leadership in engineering developments . . . a leadership which has made many contributions to advanced maintenance practices Snap-on is proud of the preference which its products have long held with maintenance executives and mechanics of this progressive airline. SNAP-ON TOOLS CORPORATION 8020-F 28th Avenue, Kenosha, Wisconsin

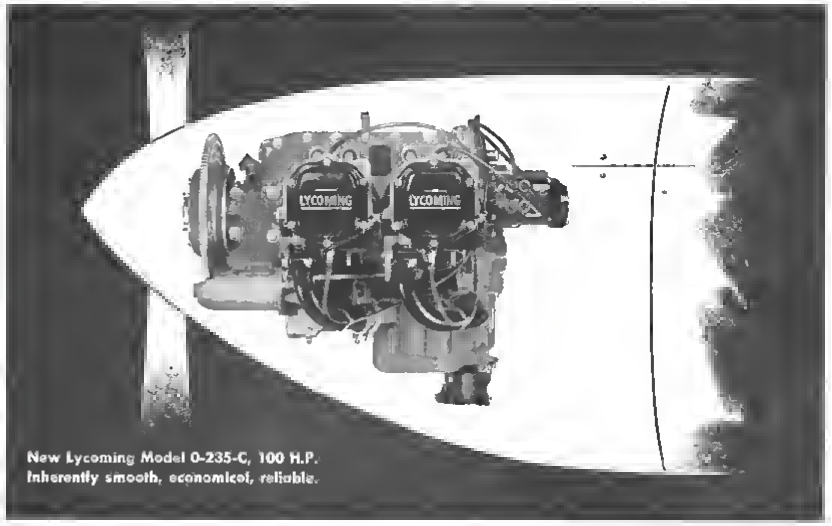


"OUR MEN PREFER Snap-ons-"

"Chicago and Southern's safety record has been called spectacular' and we will keep it so," says Superintendent of Maintenance Thomas D Brooks. "Proved maintenance procedures are ready for our DC-4's and for the big fleet of Martin 2-0-2's to follow. Snap-on tools will continue to play an important part in our maintenance operations Our men prefer Snap-ons. *It is significant that 75 per cent of the tool boxes in our main overhaul base carry the Snap-on trademark.*"



When you are *UP*— LYCOMING won't let you *DOWN!*



New Lycoming Model O-235-C, 100 H.P.
Inherently smooth, economical, reliable.

It's a "plane" fact . . . nowhere is reliability more vital than in an aviation engine. Lycoming's engineering experience, plus *years* of flight usage, is your assurance of dependability. Lycoming excels in design characteristics—rugged bearing construction, favorable horsepower-weight ratios, automotive type starter and generator mounted on the *side* of the engine, and other features. But Lycoming design never compromises Lycoming reliability. Reliability alone dictates.

For *safe, sure* flying, insist that your plane is *Powered by Lycoming.*

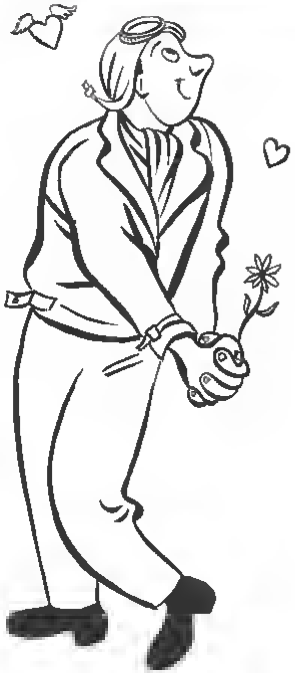
LYCOMING
AN Avco PRODUCT
AIRCRAFT ENGINES

Lycoming Division—
The Aviation Corporation,
Department B-3,
Williamsport, Pennsylvania

Please send me free booklet on Lycoming Engines. I am particularly interested in_____h p. model

Name_____ Occupation_____

Address_____



ARE YOU GETTING SWEET ON A CESSNA?

You lucky fellow! It's probably the beginning of a long and beautiful friendship! New places . . . new faces . . . more fun than you've ever had before!

May we make a little suggestion? You'll undoubtedly be flying over Phillips Territory (the great big Middle-West). Whether you set down at a big-city airport or a prairie flying field, ask for Phillips 66 Aviation Products!

They bear the seal of a great company. They were perfected by air-minded men who spend more hours in the air than behind a desk. And, for better carburation and a cleaner motor, we've taken the trouble to manufacture a plentiful supply of *un-leaded* 80 octane gasoline—and to rush it to all the Phillips fields in our territory. Patronize the "66" pump, won't you?

We'll be seeing you!

Phillips 66

AVIATION GASOLINE

A sensational non-stop flight record in which AC engineering had a part

Jet engine plug

The Army Air Forces, Lockheed, and General Electric worked a great triumph in the cross-country flight of the jet-propelled P-80's which broke all records on January 26 from Long Beach, California, to La Guardia Field, New York. Again America proved its supremacy in the air, and all the world acclaims.

AC jet engine ceramic aircraft spark plugs were furnished, on request, for all three record-breaking P-80's.

Thus, another record is added to the list of outstanding aviation accomplishments in which AC Spark Plugs have shared. From the flights of the "Lone Eagle," Maitland, Byrd, Acosta, to the recent records of The Constellation, the C-97 and these P-80's; the AC name is linked with aviation's multiplying records.

AC SPARK PLUG DIVISION
GENERAL MOTORS CORPORATION

AC SPARK PLUGS

Flying a big BASS DRUM?

Gone is that "bass drum" pounding—and in its place comes comfortable, quiet flying—when noise levels are effectively and economically reduced with Glidair Sound Deadener.

Manufacturers report that this amazing material saves 50% to 75% of their sound insulating costs—and *reduces weight* at the same time! Plane owners enthusiastically welcome the immediately noticeable decrease in flight noises.

Glidair Sound Deadener is a fibre-filled, resin type material which is applied by trowel or large-nozzle spray gun. Adhesion is excellent—even to *bare metal*. The coating air dries to handle in 4 to 6 hours and dries hard overnight. The non-sticky finish may be covered with dope, lacquer or synthetic enamels without bleeding.

Dealers and operators can obtain Glidair Sound Deadener from their nearest Glidair Distributor listed below. Manufacturers should contact Glidden Aviation Sales Headquarters.

THE GLIDDEN COMPANY

Aviation Sales Headquarters · 11001 Madison Avenue · Cleveland 2, Ohio

GLIDAIR AIRCRAFT PRODUCTS Distributed by

SNYDER AIRCRAFT CORP.	Municipal Airport, Chicago 38, Illinois
SNYDER AIRCRAFT CORP.	Sullivant Ave. Airport, Columbus 4, Ohio
SNYDER AIRCRAFT CORP.	1525 Broadway, Denver 2, Colorado
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SUPPLY DIVISION, INC.	108 Grand Ave., Oklahoma City, Oklahoma
SUPPLY DIVISION, INC.	229 E. Madison Ave., Memphis, Tennessee
MAULDIN AIRCRAFT	Brownsville, Texas
SERVAIR, INC.	City Airport, Detroit, Mich.
PIEDMONT AVIATION, INC.	Winston-Salem, N. C.
SOUTHWEST AIRMOTIVE COMPANY	Love Field, Dallas, Texas
E. W. WIGGINS AIRWAYS, INC.	Metropolitan Airport, Norwood, Mass.
AMERICAN AVIATION COMPANY	New Brighton, Minn.
FLIGHT, INC.	Municipal Airport, Cleveland, Ohio
RUFFALO AERONAUTICAL CORP.	Buffalo Airport, Buffalo N. Y.
A. W. WHITAKER	5001 S.E. Union Ave., Portland, Oregon
BERNER PEASE	3221 N. E. 2nd Ave., Miami, Florida
V. A. RUTLER	Ambler, Pa.
SOUTHWEST AIRCRAFT & MOTOR SUPPLY	Fort Worth, Texas
RICHARDSON AERO SUPPLY	Taylor Field, Ocala, Fla.

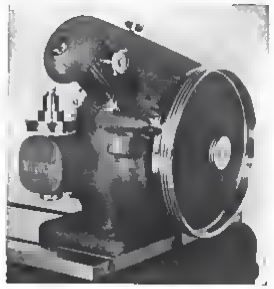
GLIDAIR FLYING COLORS

Made by Glidden Pacemaker in Paints

Send for Bulletin No. 55

30 Times MORE ACCURATE

Below is the dividing head proper, showing the micrometer, scope, and hand wheel.



What does that mean to you? It means that this proven accuracy is available to you for the inspection of gear teeth, master index plate notches, splines, cams and any other form of angular spacing. It means that final assemblies involving gears, cams, splines, etc., will be subject to less scrappage, because angular spacing errors will have been found and corrected.

Vinco guarantees the OPTICAL MASTER INSPECTION DIVIDING HEAD to be accurate within two seconds of arc; the master disk graduations to be spaced to an accuracy within ONE SECOND of arc; and the ball bearing spindle runout to be within TWENTY-FIVE MILLIONTHS of an inch, total indicator reading (the majority of spindles have less than fifteen millionths runout).

The fact that the VINCO OPTICAL MASTER INSPECTION DIVIDING HEAD has become firmly established throughout industry in such a short time is proof of its dependability and industrial necessity. The following pages cite one of many actual cases where the VINCO OPTICAL MASTER DIVIDING HEAD played a vital role in the production of a toothed part.

MILLIONTHS OF AN INCH FOR SALE BY VINCO

VINCO CORPORATION, 8665 SCHAEFER HIGHWAY, DETROIT 27, MICHIGAN; SALES OFFICES, NEW YORK, CHICAGO, CLEVELAND

Semi-Automatic Hydraulic Spline and Gear Grinder • Optical Master Inspection Dividing Head • Involute Checker • Angle Tangent to Radius Dresser • Index Plates • Precision Vises • Sine Bars • Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages • Thread Plugs, Rings and Setting Plug Gages • Spur and Helical Master Gears • Munition Gages • Propeller Shaft and Hub Gages • Built-up and Special Gages • Gear Rolling Inspection Fixtures • Indexing Fixtures • Hydraulic Power Control, Utilization and Distribution Units • Engineering, Design and Development • Precision Production Parts

They Came to VINCO

BECAUSE THEY WERE STUMPED BY A REAL "TOUGHY"

It wasn't unusual! This group of production engineers, representing a large eastern manufacturer, had used our precision production service before and were well acquainted with Vinco methods [illegible].

Their request was not an ordinary one however! We were asked to produce, in quantity, mating toothed parts with 18 slots, each slot .017" in width with a tolerance of .0003" and a root diameter held to a uniformity of .0001".

These parts were produced exactly as specified and were delivered on time and in quantities over and above specified requirements. We cite this one instance only because it is informative. Our long experience in the production of precision instruments and finely finished gages has given us a decided edge on precision production methods and techniques. Equipment and machines of our own design and make, in the capable hands of highly skilled operators, an engineering force thoroughly grounded in every phase of precision design and construction and a sales organization made up of men who combine a full engineering background with a wide and intimate knowledge of the trends and developments in the industrial field are all valid reasons for a further inquiry regarding this important phase of modern production.

Precision parts by Vinco meet your specifications. Give us the chance to prove it.

Check These Against Your Present Needs

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Extreme accuracy and flexibility of operation all combine to make this standard indicator gage practically indispensable wherever rapid and close inspection of surfaces is required. (Incidentally, it was used regularly for checking the job mentioned above.) We designed these indicator gages for use with the Vinco Optical Master Inspection Dividing Head, but because of increasing requests they are now offered for general sale.

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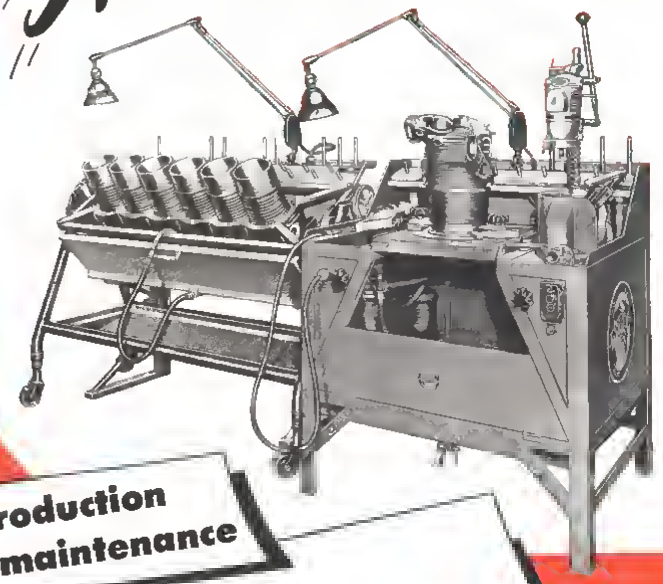
14 lb. ACTUATOR TAKES 16,000 lb. LOAD

B-29 Tail Skid Actuator, designed by Pacific-Western engineers weighs but 14 lbs., yet withstands static load of 16,000 lbs. Unit is powered by a ⅓ hp., 24 volt D C reversible motor, has a triple reduction 104-1 gear ratio and maximum operating load of 1,700 lbs Other Pacific-Western units are now serving in later craft such as Lockheed's "Constellation"

Speed With Precision



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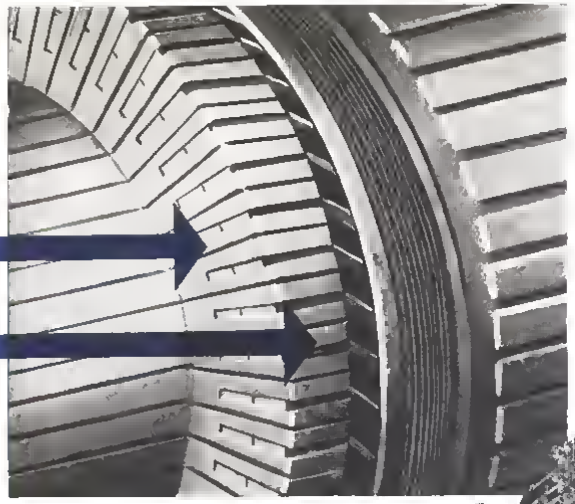
WRITE FOR DETAILS

STANDARD THE WORLD OVER

ALBERTSON & CO., INC. — SIOUX CITY, IOWA, U. S. A.

THIS *Silver-Brazed* BOND GIVES EXTRA STAMINA TO G-E AIRCRAFT GENERATORS



An exclusive feature of G-E aircraft generators is the silver-brazed bond that joins the armature windings to the commutator. This feature permits the generator to take short-time overloads which would normally cause failure in a tin soldered commutator.

In other words, one of the chief causes of heat failure has now been effectively eliminated. G-E generators can thus be made smaller and lighter without fear of damage from overheating. Shop time for generator repair and overhaul is reduced. The over-all service life of each unit is considerably lengthened.

Silver brazing of vital connections is typical of the *extra* care that goes into the manufacture of G-E aircraft generators. For example, armature and stator are protected against severe operating stresses, temperature extremes, and electrical losses by these additional construction strong points:

GLASS INSULATION — Used throughout to add greater resistance to overheating. An insulated coating on the armature punchings means low eddy losses. Slots are cushioned with strands of glass fibre.

FORMEX* WINDINGS — Armature and field coils are made with space-saving Formex wire, famed for its resistance to high temperatures, moisture, and corrosion. High strength building wire firmly bonds all windings.

SPARKLESS COMMUTATION — Compensated, interpole shunt-field windings assure sparkless commutation at all loads and speeds within the generator's rating and at high altitudes. Brush maintenance is kept to a minimum.

*Trade mark reg. U.S. Pat. Off.

GENERAL ELECTRIC

Built to withstand hard usage...

In addition to the silver-brazed connections shown above, G-E aircraft generators are doubly protected against relentless, racking vibration. A flexible shaft within the armature shaft prevents harmful engine impulses from reaching the armature assembly. It also acts as a flexible coupling between the generator and the engine. This inner shaft is further protected against breakage by a vibration damper drive. The mounting flange is specially designed and fabricated of forged steel to absorb hard punishment.

Aircraft manufacturers and airline operators, realizing that the planes of tomorrow will be judged on their ability to stay in the air and out of the repair hangar, are more and more looking to G-E for help on their electrical problems. General Electric designs and produces complete aircraft electric power systems in addition to such individual equipment as generators, voltage regulators, motors, cable, etc. Thus, G-E is in a position to offer wide experience, extensive engineering and testing facilities, and manufacturing "know how." Why not call in a G-E engineer now to discuss your electrical requirements? *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

Precision AIRCRAFT GENERATORS

DIRECT-CURRENT GENERATORS are ideally suited for single-engined planes, and combine high output with light weight and small size. Two- or four-engined planes use them in parallel with voltage regulators to meet heavier load requirements. Type P-2 is rated 200 amperes at 30 volts, with speed ranges of 2200-4500 rpm, 4400-8000 rpm, or 3000-8000 rpm. Type R-1—300 amperes at 30 volts, with speed ranges of 4500-8000 rpm, and 3300-8000 rpm. Type Q-1—400 amperes at 30 volts, with speed range of 4100-8000 rpm.

A-C Constant-Frequency GENERATORS

A-c power systems for larger aircraft are now made possible through the use of G-E 400-cycle, a-c generators, operating at constant frequency. Capacities include 40 kva, 208/120 volt, 6000 rpm, 20 kva, 208-120 volts, 8000 rpm.

A-C Variable-Frequency GENERATORS

G-E makes a unit rated 200 amperes, 30 volts d-c/40 amperes, 120 volts, single-phase, 800-1600 cycles, a-c; and one rated 10 kva, 0.9 pf, 208-120 volts, three-phase (400-800 cycles, a-c).

Gas-Turbine Starter GENERATORS

Pioneer in aircraft-turbine design, G-E also builds starter-generators for use with gas turbines. One outstanding type operates on 400-cycle, 30-volt, d-c power over a speed range of 3700/7200 rpm.

"UNIMOLD LEADS" with TWA

CUT-AWAY VIEW OF UNIMOLD

Increased Ignition Service Life
New Operating Economies

All Wright-powered DC 3's and Stratoliners of TWA-Trans World Airline are now being equipped with Unimold Ignition Harnesses by Titeflex. *Always* alert for new developments to increase operating efficiency, TWA maintenance officials conducted exhaustive flight tests with Unimold Leads which conclusively proved that maintenance economies are effected by using Unimold detachable lead ignition assemblies.

In TWA flight tests *not one electrical failure* developed in any of the ten lead *sets* tested. When all planes are Unimold equipped a large decrease in flight delays previously caused by ignition difficulties is anticipated.

In Unimold ignition leads the conductor and end terminals are molded in one complete unit—preventing moisture and gas penetration—minimizing "corona" and "flash-over". Added to economy and service life—superior radio shielding qualities of Unimold assemblies explain why so many commercial aircraft are being equipped with Unimolds. For further information on molded ignition assemblies by Titeflex, write us on your company stationery.

Titeflex

Titeflex, Inc., 510 Frelinghuysen Avenue, Newark 5, New Jersey

Congress has acted—and along these lines—since this editorial was written. If the President signs the legislation, we have taken one step forward. If he vetoes it, the voters must resolve a conflict between two branches of their government.

THE LABOR CRISIS
—*it's up to Congress*

IT HAS remained for John L. Lewis to demonstrate conclusively that, under the sponsorship of the federal government, the power of organized labor has been built up to a point where it can be used to paralyze the economic life of the nation. Therefore, in the elemental interest of self-preservation, the first order of the day is to cut down the power of organized labor to a point where irresponsible leaders no longer have the power to use it to cut down the country.

This will prove an exceedingly complicated job. The federal government, over a dozen years, has developed and buttressed the power of organized labor by many separate steps. They are interlaced in a pattern which cannot easily be unravelled.

Cutting down the power of organized labor to proper proportions will be an operation almost as delicate as brain surgery. To be successful it must impair no basic American political or economic right. It must leave intact the right of workers to organize and bargain collectively through representatives of their own choosing. It must leave intact the right to strike. But it must disassociate from the exercise of these rights opportunities for devastating abuse of the public welfare such as those demonstrated by Mr. Lewis. A meat axe is not the instrument for this operation.

Because of the complexity and delicacy of the operation to be performed it would be helpful if it could be carried out in a tranquil atmosphere. The urgency of the problem is such, however, that no time can be lost in getting at it.

Guiding Principles

However, the dangers that haste or heat will lead to serious blunders can be largely eliminated if the process of bringing the power of organized labor back within safe and reasonable bounds is governed by principles to which all fair minded people can fully subscribe.

The most important of these principles is that it is an abuse of public authority to extend special privileges to organized labor.

When in 1935 Congress passed the Wagner Labor Relations Act, one of the great buttresses of the power of organized labor, it was upon the explicit theory that organized labor was weak and needed coddling by the federal government if it were to survive, let alone grow big and strong. In the policy section of that act it was stated that "the inequality of bargaining power between employees who do not possess full freedom of association or actual liberty of contract, and employers who are organized in the corporate or other forms of ownership association substantially burdens and affects the flow of commerce . . . "

Regardless of whether or not that was a correct reflection of the situation in 1935, it bears no relation to the situation today. Under the continuous sponsorship of the federal government, the power and bulk of organized labor has waxed until today it is preposterous to regard it as the weak sister in its bargaining with employers. If, after being continuously demonstrated since V-J Day, the proposition that the pendulum of organized power has swung too far over on the side of organized labor needed any final and clinching demonstration, John L. Lewis provided it.

Changes in the Law

Translation of the principle that organized labor is no longer a weakling, requiring a diet of special privileges, into specific legislative enactments is a detailed technical operation beyond the scope of this statement. It is possible, however, to indicate some of the general lines it should follow. Here they are.

1. The duty to bargain collectively, now imposed upon employers by the Wagner Act, should also be imposed upon the leaders of organized labor who are now under no legal compulsion to bargain.

For well over a month Mr. Lewis made a complete mockery of the process of collective bargaining by refusing even to state his demands until the coal operators had approved "in principle" a plan for a miners' "health and welfare" fund which he fancied. In the meantime the country was plunged into an ever deepening crisis.

2. Unions, as well as employers, should be made liable to suit for damages for breaking their collective bargaining agreements.

A degree of responsibility commensurate with their age and power requires that unions be liable, to the extent of union funds but not the funds of individual members, for carrying out their agreements. To have it otherwise is to hold that a collective bargaining agreement is, by defi-

nution, a phoney agreement so far as the union is concerned. Outlaw strikes are the fruit of this lop-sided arrangement.

3. Employers should be given more discretion, in reinstating employees who have gone on strike than is now permitted by the Wagner Act.

The Wagner Act largely eliminates the risks involved in striking because of the requirements it imposes upon employers to take workers back when they have decided to return to work. These requirements make it virtually impossible for the employer to replace workers even if they are engaged in the most unjustifiable of strikes. At the least workers who have smashed up property and stirred up violence in the course of a strike should have no rights under the Wagner Act. How much further the Wagner Act straitjacket should be loosened at this point should be carefully explored, and excesses encouraged by the Act should be removed.

4. The wedge which the National Labor Relations Board has driven into the orderly conduct of American industry by holding that foremen are covered by the Wagner Act should be eliminated.

The issue involved here is continuously mislabelled and confused as that of the right of foremen to organize. There is no question of the right of foremen to organize any kind of a legal organization they desire. That is their right as American citizens. The issue is whether or not the special privileges accorded by the Wagner Act, which in some circumstances has been so construed as even to prevent employers from talking with their workers, should be extended to foremen who, if American industry is to have a chance to do its duty effectively, must represent management with full loyalty and responsibility.

A member of John L. Lewis' United Mine Workers takes an oath which provides, in part, "that I will not reveal to any employer or boss the name of anyone a member of our union" and will "defend on all occasions and to the extent of my ability the members of our organization." Mr. Lewis insists that the coal operators contract to deal with foreman to be organized in a union where they will take that oath, and where their activities will be separated from the influence of employers by the barriers imposed by the Wagner Act. Such an arrangement undercuts orderly management of American industry.

5. The exemption of labor unions from the federal anti-trust laws, provided when organized labor was presumed to be weak, should be modified to take account of its vastly increased strength, and the use of this strength to destroy business enterprise and create monopoly.

As matters stand unions can run employers completely out of business by secondary boycotts and run fellow workers out of jobs in the process. An Ohio manufacturer, working with a government-certified C. I. O. union, is put out of business because A. F. of L. workers refuse to handle his products. Still the government, this time in the person of the United States Supreme Court, says that actions of this sort are above the law because Congress exempted unions from the federal anti-trust laws.

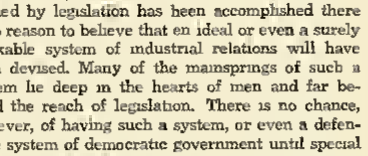
To eliminate one of the most devastating forms of restraint of trade, this exemption should be cut down forthwith by subjecting unions imposing secondary boycotts to the same penalties under the federal anti-trust laws as those to which employers doing the same thing are subjected. And the question of further narrowing the obsolete exemption of unions from the federal anti-trust laws should be fully explored.

6. The levying of special sales taxes for the exclusive benefit of unions should be prohibited by law.

As a matter of good government the right to levy consumption taxes should be reserved to the public authorities and used strictly for public purposes. As a matter of good economics, payments to workers or their organizations should be included in the payroll where they can be properly counted as part of the cost of production.

Equality Before the Law

When everything that can conceivably be accomplished by legislation has been accomplished there is no reason to believe that an ideal or even a surely workable system of industrial relations will have been devised. Many of the mainsprings of such a system lie deep in the hearts of men and far beyond the reach of legislation. There is no chance, however, of having such a system, or even a defensible system of democratic government until special privileges which tip the scales of power far on the side of organized labor are withdrawn and there is some measure of equality for employers and organized labor before the law. Though it is hard to believe it at the moment the country may come to be grateful to John L. Lewis for driving that lesson home so ruthlessly.



President, McGraw-Hill Publishing Company, Inc.

THIS IS THE 48th OF A SERIES

EDITORIAL

Here's an "Or Else" For the Lightplane Business

DURING 1946 about 20,000 Americans will buy personal planes. Many of them will become pilots—a new experience. A certain percentage will be disappointed in flying; their craft will be offered for sale, and probably resold later. Yet, there will be many thousands whose orders cannot be filled until next year. And 1947 should be even better, unless economic conditions prevent. The new Federal Airport legislation will contribute to the personal flying activity. But where do we go from there?

It is all well and good for the manufacturers, salesmen, fixed base operators, and others who will profit, to rub their hands vigorously and think, "This is the boom we have been waiting for." And it is. But one may ask, "Just what are you fellows doing to keep this business going after the first buying wave has receded?" Here are a few thoughts in that direction:

Manufacturers must not shirk industrial management's traditional responsibility—to give the consumer even more for his dollar. This is the fundamental secret of success in any business. And airplane making is no different from anything else. This responsibility is vested not only in the builder of aircraft. Every maker of parts or equipment must share it.

In our May issue we told the story of a manufacturer who left no stone unturned to reduce his costs. He went back to basic engineering and simplified design, and there he accomplished part of his aim. He bought an engine company of his own, and that helped some more. He whittled down prices relentlessly for every part and piece of material that went into that airplane. And he is still doing it. Then, too, he opened his shop to his competitors and told them freely what he was doing.

Maybe you don't agree with this man but it might be wise to follow his example, because the customers like his product and his price—and that's all that counts.

ONE ACCESSORY MANUFACTURER who couldn't meet this project's price competition reported he was happy about losing the business. He said it was a good test for him and that he was going back to research in order to design a product that would undersell his competitors. This is the spirit which has made American industry great. It is highly encouraging to find it in the aviation business.

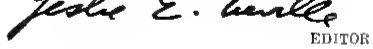
Aviation has become a real business. The days of fat markup for commercial products, because they are stamped "aviation," are numbered. Someone is going to get cost down for aviation products. And it would be far better for the experienced old timers to do the job than for new comers to take the business away from them.

In recent weeks, reports from new plane owners indicate that some manufacturers are exaggerating weight allowances for their craft. This practice reminiscent of the late '20s constitutes the worst possible business practice. It is true that many well-designed aircraft will safely carry more than their certified load, but it is inexcusable for manufacturers to allow their planes to be sold on such a basis, even if an increased allowance is confidently expected. Nothing could do the industry more harm. It is the responsibility of the individual manufacturer and the Personal Aircraft Council to check this practice before it becomes widespread.

THE AIRCRAFT DISTRIBUTOR and the airport operator also have a broader responsibility to the customer than is generally realized. Like manufacturers their most important job is to work relentlessly to cut the cost of airplane ownership. Hangar rental is the big fixed item of expense for the owner. The large hangar with its high, elaborate roof structure is an excellent place for maintenance work but uneconomical for aircraft storage. In spite of present high building cost, individual hangars can be constructed at prices low enough to provide reduced rental, and on a reasonable basis of amortization. It is a good idea to build a few blocks of them now, maintain a reasonable rental in keeping with the present demand, and be prepared to reduce these rates later when demand levels off. There are many other ways in which increased operating efficiency can be passed on to the customer, and reduced flying cost will enable more people to own planes.

Another frequently unrecognized responsibility of the operator is to help make flying more interesting. All past experience shows that interest in plane ownership begins to lag after a season or so of hopping in and out of the home airport. Cross-country flying must be encouraged and stimulated, and this can be done with little effort on the part of the operator. Seek out some gregarious customer with sufficient leisure to organize tours and breakfast flights, and show him how to have this fun. Others will follow, and thus new interest in flying is developed.

These are but a few of the things that can be done to keep this business going. Many ideas will present themselves to the alert and imaginative operator. When airplanes are made economical and useful objects of recreational desires, personal flying will come into its own and the future of this fascinating field will be assured.



EDITOR

"CROSSROADS" CRITIQUE

By HERB POWELL, *Associate Editor, 'Aviation'*

Examining both accepted and disputed fundamentals behind the imminent Atom Blast Fnar, this preview relates the whys and hows of the comprehensive test at Bikini—where aviation's leading role will be accented.

FOR GREATEST CLARITY in our conception of Bikini, it's best that we first carefully examine the record of the A-bomb to date—to obviate the many confusions which are hazing its status.

To run our finger down the fundamentals, let us specifically note that fast nuclear fission, and the apprehensive age it ushered in, is not even a year old. Yet, in this relatively short time, myriad problems have been posed and then pounded under an unparalleled flood of public concern, with minds the world over attempting to grasp the new significances. Heavy pressure of this attention is fogging the facts.

Fundamental No. 1 is that we still know next to nothing about the A-bomb's key characteristics, and it certainly behooves us to go about the business of noting and gaging them. There are those who would ban such tests as Operation Crossroads. But contrary to their contentions, full knowledge gained can actually aid us in following the humanitarian, rather than militaristic, path into the future. From now on, we will have to carry this Pandora's box with us, and we'd better know precisely what's inside it. Lack of such knowledge can only lead to false security. The ostrich has taught us that there is no sense in the premise that "what you don't know won't hurt you."

It could hardly be expected that comprehensive information could be gathered in the course of the three previous A-bomb detonations. At Almagordo, in July 1945, there was not an iota of past experience for the scientists to go on. They were understandably chary in this initial approach. Moreover, neither theories nor apparatus of investigation had then been brought to satisfactory development.

With Hiroshima and Nagasaki, in August, there did come additional understanding. Granted. But these blasts were under war conditions, requisite studies could not be mounted in the direct face of the enemy.

Accordingly, the fourth blast—slated at Bikini Atoll next month—stands as the first opportunity in which essential implementation, instrumentation, personnel, and timing are being arrayed to determine data sought. So, on our first fundamental, Bikini makes sense.

Fundamental No. 2 is that A-bomb operations are distinctly of the air, not of the land or of the sea, even though experimental variations may be tried (such as the plan for detonating Blast Five from a barge, in order to assure explosion at or just below water level). We find aircraft the key to A-bomb carriage today, with the Boeing B-29 exemplifying the type of plane currently affording the capacity to handle these new destroyers. Hence, the basic role of aviation in the A-bomb scheme is evident.

It would be begging the question to try to discount aviation at this point by theorizing that warships might have pumped these blisters into Japan with special guns. This would imply the use of a much too slow assault medium. Speed must go with speed. Besides, it is a fair assumption that various mechanics of such a non-plane attack would be faulty.

Tomorrow, true enough, special projectiles hurtling far above the earth at supersonic speeds are visualized doing the carrying job. Yet even these missiles may well come under the aviation definition, specifically so if they require some kind of wing (fin) design.

In any event, however, we should steer clear of the over-the-boundary type of future-thinking. There's an analogy in the unrealistic attempt to tie the "obsolete" tag on the aircraft carrier. This kind of erroneous ranging might lead us astray with our aircraft-A-bomb team, a combine which we may logically figure will continue.

Turning now to specific considerations of joint Army-Navy Task Force 1's fourth blast at Bikini, we find the target involving more than 70 surface vessels disposed in concentric fashion, with the Battleship *Nevada* at the hub. Next out from this aiming point will be ranged other major ships (battleships, cruisers, and carriers), such as the *Nagato, Pensacola, Independence, Sakawa, Arkansas, New York,* and *Salt Lake City*. Somewhat farther out come the *Pennsylvania, Saratoga,* and *Prince Eugen*. Then "filling in" at varying distances will be destroyers, submarines, attack transports, landing craft, a floating drydock, and a barge. The pattern has been carefully planned to test effects in ratio to distance. Features of a typical anchorage, also of a task force at sea have been integrated in the layout.

Carrying out the many different air missions will be some four score directly involved aircraft, along with a miscellany of others. Their types and operations will be detailed in later paragraphs. The bomb itself (stated to be the same type as that used at Nagasaki) is to be detonated in the air over the target fleet. In a later test (perhaps in August) a fifth blast is projected at the surface of the water. There are also plans—at this writing seemingly only tentative—for an underwater blast test in 1947.

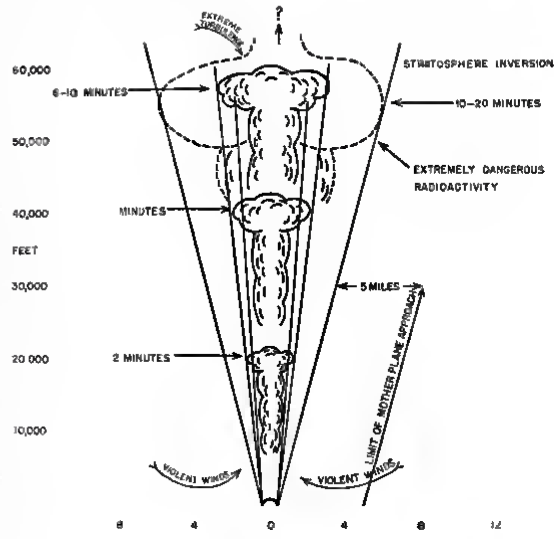
At this point, we may call it Fundamental No. 3 to evaluate all controversial angles. For one thing, the matter of the underwater blast has stirred up considerable contention on the part of scientists, who appear agreed that it is this test which promises to send the most destructive forces against naval vessels, because of the fact that, as compared to the air medium, the water medium will translate greater compression farther. Convinced that a strikingly higher violence would be set up by this underwater bomb, the savants see little relative significance in the fourth blast, and not much more in the fifth. They raise a sharp question at the seeming lack of definite plans for what they term the really meaningful sixth blast.

A very harmful public reaction is feared—because the strongly built, water-cushioned vessels may well resist the forces of the fourth and fifth detonations. Foreseen are heavy headlines reading, "A-Bomb Fails To Destroy Fleet"—leading the man-in-the-street to an extremely erroneous, "See, it isn't what it's cracked up to be." Test leaders themselves bear out this unfortunate possibility, admitting that results will not be "so overwhelming or so unexpected" as to solve prime questions of future Navy or Air Force needs, of obsolescence of surface ships, or of new tactics and strategies of bombing.

This opens up two further questions: Since an A-bomb heeled enemy would be expected to strike directly at our major cities, rather than at our fleet, why not test the bomb against a city with occidental buildings "and really find out what we may be in for." Here,

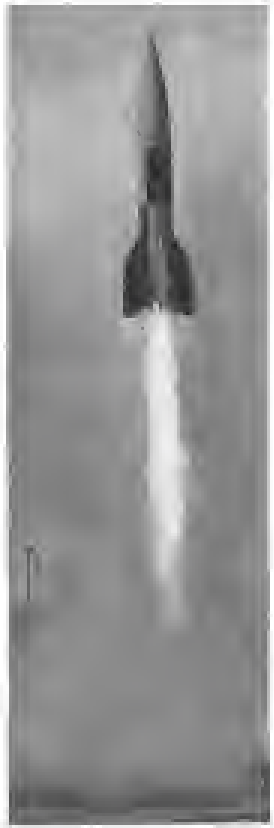
(*Turn to page* 150)

Controlled from panel (left foreground), Navy Hellcat drone streaks to robot takeoff from deck of carrier Shangri-La. Such pilotless craft will weave through blast cloud to beg atomized air and get instrument recordings, then be "mothered" to landings for scientific investigations. Should strong radioactivity kill ignition systems and crash drones such toys may be seen as new weapon. (Press Assn. photo)



Blast cloud will be particular object of study at Bikini. Sketch shows probable position of rising cloud at intervals after explosion. As noted, "mother" planes guiding drones will not fly into danger area in immediate vicinity of blast. (Joint AN Task Force 1 photo)

CAN WE CATCH UP IN ROCKET RESEARCH?



Captured German V-2 rocket—assembled and prepared for launching under German supervision—soars skyward at White Sands N. M. Proving Ground. Its warhead replaced with a "peacehead" of scientific instruments, rocket helps U.S. learn now what Germans started to learn twelve years ago when they began guided missile program. (Press Assn. photo)

By E. J. TANGERMAN, *McGraw-Hill Representative at White Sands Rocket Tests*

An eye-witness account of V-2 and "WAC Corporal" launchings points up need for continued research and development in guided missile program—especially important in view of atomic developments.

IT HAS BEEN BUT a remarkably short time since a workaday reporter could have a terrifying day by going to Aberdeen Proving Grounds to watch the firing of a 16-in. gun. But then American military science caught up with—and passed—Buck Rogers with the Bazooka, Super Bazooka, Mousetrap, Minnie Mouse, Holy Moses, Tiny Tim, Xylophone, Calliope, Grand Slam, Woofus, Whiz Bang, Honeycomb and Snake, all innocent sounding names for super-lethal rockets and rocket launchers.

But the most spectacular rocket of all still is the Nazi V-2, which was demonstrated for some 40 newsmen, photographers and movie cameramen—and again as many top military men—at White Sands Proving Ground, N. M., on May 10.

Curiously enough the rocket is not a new weapon, but a modernized one. The Chinese launched rockets against the Mongols in 1232, rockets were a terrorizing weapon in Europe 100 yr. later. Cannon outmoded them—until native Indian troops used them against the British toward the close of the 18th century. Following traditional military procedure, the British developed rockets of their own, and used them against Napoleon and against Fort McHenry in Baltimore to help a certain poet named Key write the "Star Spangled Banner." Only 32 yr. later—100 yr. ago—the United States Army created its first rocket battery. We used pinning rockets against Mexico at Vera Cruz and in storming Chapultepec, then gave them up. The rise of the airplane in World War I suggested rockets again, but it was not until World War II that they came back—and with a vengeance.

"Vengeance" was the word that gave the German A14 rocket its propaganda title "V-2". It differs from military predecessors in being liquid-fueled, and in being far larger. Our largest rocket, the WAC Corporal, is a foot in diameter, 16 ft. long, and weighs 700 lb. at launching; the V-2 is 5 ft. in diameter, 46 ft. long and weighs 28,000 lb. (Its powerplant was analyzed in detail in last month's AVIATION—p. 63—By Ray Healy, AAF rocket consultant.)

As a weapon, the V-2 was of limited strategic significance—it was very costly considering its small payload, limited range and accuracy. But the development of the atomic bomb changes the picture; now development of accurate long-range missiles is of extreme importance. Laterally, the sky is the limit; for the Ordnance Dept. is building test equipment for rockets ten times as big as the V-2—a temptation for designers to devise them. And consider for a moment the production from only one German plant—the underground unit at Nordhausen—which turned out 900 V-2's per month. With atomic warheads, they'd have been vengeance weapons and no mistake.

The V-2 was no sudden development; it took 12 yr. by the best available German scientists and millions of dollars. We are now capitalizing on this work to obtain fundamental information which will help us develop better, longer range missiles. To speed the job, we brought over parts for some 25 V-2's and placed in "protective custody" a number of German scientists connected with guided-missile research for over ten yr. at Peenemunde. These scientists are now working quietly at White Sands indexing and translating captured documents (thank goodness, the methodical Germans record *everything*), identifying rocket material, assisting in assembling and firing V-2's, and providing technical information on rocket design. They have also assisted in training the detachments assigned for handling, firing and tracking the rockets, and in setting up portions of the elaborate system of synchronized radio, radar, photographic and visual equipment used to observe and record the behavior of the rockets in flight. These scientists are under contract for a limited period, their nominal salaries going to their families in Germany. They are allowed no access to our own classified projects, and leave their designated area only with military escort. Those I talked to were happy as clams with their giant toys, and would like to stay here.

To assemble the V-2's, replace missing parts, repair damaged ones and provide fuels, General Electric has been employed. This permits a variety of additional test objectives, including testing of alternate components, use of radar in tracking and in countermeasures, developing of instrumentation and studying of trajectories, upper-atmosphere physics and the like.

To accomplish these objectives, the warhead of the V-2, with its explosive filling, becomes a "peacehead" filled with scientific paraphernalia for exploring the upper atmosphere and for evaluating the performance of the propulsive system and automatic controls of the rocket. The fuel supply used by the Nazis to fire rockets into London from launching areas more than 200 miles away on the continent, over a trajectory reaching a height of 60 miles, can, when the automatic controls are set properly, send them up to twice that height in a very nearly vertical trajectory ending in a safe impact area within the Proving Ground.

In current tests the height attained will be about 100 mi. The V-2 launched May 10 went 72 mi. (127,000 yd.) high and landed 39 mi. from the firing point. Fuel remaining when burning was terminated by remote control exploded on impact, gouging out a hole 20 ft. deep and 30 ft. across and burying the head in hard clay and gypsum sand. Actually, the 10 tons of fuel in a V-2 has more energy content than its 1800-lb. warhead by many times, even the remainder frequently matching the warhead in power. Lateral error was only 340 yds., or about 0.5%.

As fired against London, about 14,000 lb. of gas expelled at an average velocity of 6800 fps. gave about 10,000 lb. of rocket and unburned propellants a forward velocity of 4900 fps. when the fuel supply was cut off and burning ceased. This happened about 60 sec. after take-off when the rocket had travelled 25 mi. along its trajectory and was moving in a direction 47 deg. away from the vertical, i.e., 43 deg. above the horizontal, at a point 17.5 mi. above the ground and 15.5 mi. longitudinally from the launcher. The normal trajectory started the fourth second, fuel was cut off at 67 sec. and 3,440 mph., 22 mi. from the launcher and 24 mi. in the air. Maximum elevation of 50.8 mi. was reached at 176 sec. and 147 mi. and impact was at 306 sec. and 182 mi. This takes the V-2 through the troposphere (to 40,000 ft.), the stratosphere (40,000 to 270,000 ft.) and into the Heaviside layer (270 000 to 320,000 ft.). The Mav 10 shot went beyond the ionosphere, establishing an American record of 360 000 ft.

During the burning period, direction of the rocket is controlled by the action of four movable vanes in the fins and four graphite ones in the jet—the latter essential during the low-velocity starting period when the fin vanes have no aerodynamic effect. Vanes 1 and 3 in both groups are in tandem to control roll and yaw. Vanes 2 and 4 in the jet path control pitch, while fin vanes 2 and 4 act as stabilizers. The 1 and 3 vanes and stabilizers 2 and 4 (independently motored) are controlled by a gyroscope to maintain the axis of the rocket in the vertical plane through the launching and target points, thus keeping the rocket heading in the right direction.

Jet vanes 2 and 4 are controlled by another gyroscope to produce and maintain correct inclination of the trajectory during the burning period. This second gyroscope is subject to the control of a third gyroscopic system, the real brains of the missile, which serves to maintain vertical travel to a height of about one mi., then to tilt the rocket slowly away from the vertical until it travels on the desired course, thereafter to maintain this course until the velocity is correct for the range desired, and finally, to cut off the fuel supply at that velocity, thus ending propulsion. Fuel cut-off can also be accomplished by remote control from the ground. After jet propulsion has ceased, the rocket behaves

(*Turn to page 148*)

V-2 is rigged for launching at White Sands Proving Ground. Note carrying trailer and cradle used for raising rocket into vertical launching position. Mobile tank at left contains alcohol which forms part of fuel.

Sound Financial Status Braces Industry in Readjustment

BY RAYMOND L. HOADLEY, *Financial Editor of 'Aviation'*

Our annual survey reveals that manufacturers' resources are now tiding firms through two-year realignment period, with gloom banished by a $90 million reconversion reserve and low inventories. Accordingly, the industry now rises out of the survival stage to initiate true profit-seeking.

THE AIRCRAFT INDUSTRY can't get away from its wartime habit of setting new high records each year. Granted, our annual survey shows that sales and earnings were somewhat lower in 1945 than in 1944. But the industry's collective balance sheet shows a new high record of financial strength and resources for America's No 1 security industry.

This sixth in our series of annual financial surveys of the aircraft industry is probably the most significant since, among other interesting data, it reveals one particularly salient fact

The aircraft industry today has sufficient financial resources to carry it through the remaining year or two of postwar readjustment, while meantime the American people and Congress decide (1) what they want in the way of a future air force and (2) what degree of strength is accordingly requisite in the aircraft industry

The plane makers have done much more than merely maintain solvency. They have gone ahead and gained a position of financial soundness—thus confounding the experts and their friendly critics both within and without the industry

You will remember with a shudder those statements made by well-meaning observers a little time back—that the industry wouldn't be able to meet more than two weeks payrolls after the war ended. Some feared that huge inventory losses would cut balance sheets to shreds

Quite rightly, there was much talk of the coming "financial distress" back in '44, when the industry's problems seemed over-powering. It was thought in some circles that a huge amount of financing would be required during the reconversion period

Those Three Risks

Researchers of one leading university made a study of the financial condition of leading aircraft concerns—and came to the conclusion that the industry faced three major risks right after the war

1 Existing corporate resources might prove inadequate to absorb losses resulting from contract termination and inventory liquidation.

2 Subsequent costs of contraction and conversion might consume a substantial part, if not all, of available funds

3 Remaining capital, together with that which the firms appeared capable of raising, might prove inadequate for maintenance of peacetime employment and production

That's what the professors (and many others) thought when the outlook admittedly appeared tough. Here, however, is the way the industry's financial cards actually stacked up at the beginning of 1946

Despite the fact that reconversion had begun, postwar reserves were substantially larger than they were at the start of 1945.

Cash and net working capital jumped ahead while current liabilities declined and the figure for bank debt showed little change.

Inventories were down 50% (or more in some cases) from their wartime peak. Dividend payments declined only slightly, and profit margins on sales continued among the lowest of America's great industries

Let us consider a more detailed survey of the aircraft financial facts of 1945 and then relation to the present readjustment period

Inventories of reporting companies aggregated $86,888 610 last year against $124,765,000 in '44 and $138,050,000 in '43 The large manufacturers appear to have their inventory situation well in hand while, given availability of materials and parts, some of the smaller, personal plane makers would like decidedly larger inventories than they do have

Last year's sales by the reporting concerns were $3,567 160,535, against '44 sales of $4,722,084,823 and $3,257,933,250 in '43 The decline, of course, was to be expected in view of the multitude of contract termination orders that flowed from Washington following V-E Day and again after V-J Day.

Net earnings for the group, however, stood up much better than might be expected, totaling $53,415,254, against $57,628,686 the previous year and $40,894,540 in '43

Tax charges last year came to $140,064,000 There was a time when some questioned the industry's ability to meet its taxes when the war was over. Yet the industry seems to have ample cash resources to meet the tax collector's demands

Perhaps the most promising feature of the industry's composite balance sheet for 1945 is its rainy-day reserve The companies reporting had, at the year end, contingent reserves of $117,977,202 to use for reconversion or readjustment In fact, such reserves were more than $35,500,000 higher than in '44 and $47,000 000 higher than in '43

Some companies drew down a bit on reserves late last year, but not enough to make much of a dent in the large totals most concerns accumulated during the war years. It is already evident that most companies will not find it necessary to use these rainy day reserves during their reconversion period The result is that during 1946 the management of such companies as Douglas and United Aircraft—to cite only two—will have to decide on what permanent disposition to make of these specific funds

LATEST UNFILLED ORDERS

Boeing	$90 000 000
Consolidated	215 000 000
Curtiss Wright	86 000 000
Douglas	219 000 000
Fairchild	78 200 000*
North American	75 000 000
Northrop	53 500 000
Piper	12 000 000
Republic	48 270 090
United Aircraft	113 000 000
Total	$974 076 000

* Exclusive of letters of intent of approximately $2 [illegible]

Turning to other balance sheet items we find that current assets of the reporting companies last year were $639 835,000, against current liabilities of $343,890,000 That leaves an aggregate net working capital of $295,945,000—and that's more than pin money

To be on the safe side, most aircraft companies negotiated huge V, VT, or T-loans during the war years Such agreements made available some $600,000,000 to the industry for financing war contracts or terminations But the industry found surprisingly little need for such credit, due largely, we presume, to the government's program of making partial or advance payments on terminated contracts Anyhow, at the end of 1945, bank debt for the reporting companies came to only $13,704 000

Last year, survival—not profit making—was the main objective of the industry. That's not true today, except perhaps in the case of some struggling personal plane companies which are either entering production for the first time or are not abundantly supplied with cash resources

As for the others, there will be no casualties, at least until their current cash cushion is used up But, because of the great present-day expense in developing and producing new models, the balance sheets of some aircraft makers may not look as good a year from now as they do today

Admittedly, the earnings outlook this year is none too promising One company had a loss of nearly $1,000,000 at the end of the first two months of 1946 Yet while some firms may just about break even on the year, on the other hand there are a few that may show quite profitable operation

Poor profits in '46 are symptomatic of the readjustment period, in the judgment of the industry—which now presses forward intent on making sure they are only symptomatic

THREE-YEAR COMPARISON OF 21 AIRCRAFT MANUFACTURERS

	Sales 1945	Sales 1944	Sales 1943	Net Income 1945	Net Income 1944	Net Income 1943	Readjustment Reserves 1945	Readjustment Reserves 1944	Readjustment Reserves 1943
Aeronca	$4 074 212	$4 768 582	$12 078 638	$100 038	$145 831	$264 844	$100 000	$213 700	$158 000
Aviation Corp		81 268 097	45 503 538		3 106 170	4 723 884		800 000	1 800 000
Beech	123 751 822	93 103 000	89 829 000	3 722 402	2 705 481	2 210 596			
Bell	278 416 816	317 473 878	232 134 028	4 485 297	3 158 975	2 462 414	4 200 000	3 600 600	—
Bellanca	9 000 832	6 032 982	6 122 402	373 631	201 862	332 227			
Boeing	421 147 017	603 982 413	403 188 181	6 488 703	5 257 322	4 482 870	16 375 000	2 660 000	2 600 000
Cessna		40 386 000	70 729 401		1 102 000	2 208 000	—		831 000
Consolidated	645 052 838[2]	960 018 000	800 578 000	7 028 932	12 424 000	12 278 000		8 500 000	13 100 000
Curtiss-Wright	612 588 000[1]	1 716 935 177	1 395 236 317		14 231 063	12 383 347	32 831 000	24 311 000	15 223 000
Douglas	744 882 664	1 061 407 485	887 687 160	8 955 754	7 685 227	8 352 257	15 652 000	8 760 000	8 850 000
Fairchild	41 881 481	33 219 963	102 450 394	988 034	1 173 123	1 827 211	3 587 102	2 500 000	1 200 000
Grumman	236 848 863	323 749 331	278 095 001	5 713 528	9 550 001	4 643 203	4 500 000	2 000 000	1 380 000
Lockheed		693 363 864	669 152 490		4 322 848	7 888 420	—	1 067 000	8 000 000
Martin		537 409 444	508 072 796		4 909 872	2 838 456		16 000 000	10 000 000
North American		718 003 458	660 139 000		8 389 887	6 790 323		7 000 000	5 000 000
Northrop[3]	68 413 350	88 045 059	69 791 844	747 501	663 518	1 249 335		183 000	
Piper	7 700 850	2 230 087	4 878 507	143 152	187 823	210 883	81 000	33 000	162 500
Republic	222 148 329	309 503 425	282 881 087	1 880 778	2 802 186	3 025 854	4 387 000	1 453 000	2 845 000
Ryan[4]	45 003 000	66 085 433	25 357 541	244 886	703 345	587 312	621 700	530 000	240 000
United	484 310 508	743 627 683	733 500 868	12 858 280	15 962 338	10 306 114	38 346 000	38 078 000	30 205 000
Waco	13 388 201	12 046 663	14 660 390	92 328	106 943	129 881	30 000	31 000	206 000

	Cash & Bonds 1945	Cash & Bonds 1944	Cash & Bonds 1943	Earnings Per Share 1945	Earnings Per Share 1944	Earnings Per Share 1943	Dividends 1945	Dividends 1944	Dividends 1943
Aeronca	$558 300	$1 255 000	$203 000	$0 41	$0 93	$1 55	$0 10	$0 10	
Aviation Corp		10 458 000	7 904 000		0 54	0 40	0 20	0 20	0 20
Beech	14 667 000	8 581 000	16 138 000	3 30	0 76	5 54	1 00	1 00	1 50
Bell	26 100 000	27 262 000	16 456 000	10 38	8 01	6 25	1 00	1 00	1 00
Bellanca	406 000	707 000	640 000	1 10	1 27	1 44	0 50	0 50	0 50
Boeing	41 071 000	11 038 000	15 345 000	5 00	4 88	4 14	1 00	2 00	2 00
Cessna		2 225 000	21 300 000		1 87	3 15	0 25	0 40	1 00
Consolidated		56 998 000	56 724 000	4 92	8 80	8 67	2 00	2 00	1 50
Curtiss-Wright		237 531 000	258 085 000		1 62	1 42	0 50	0 75	0 75
Douglas	46 832 000	31 701 000	41 300 000	14 93	12 81	9 32	5 00	5 00	5 00
Fairchild	3 858 148	3 192 000	1 086 000	34	1 12	1 75	0 20	0 20	0 20
Grumman	29 002 000	15 142 000	19 313 000	11 24	18 90	8 58	1 50	1 50	1 50
Lockheed		27 440 000	87 400 000		4 20	7 42	2 00	2 00	2 50
Martin	—	41 034 000	85 750 000	—	4 37	2 68	3 00	3 00	3 00
North American		78 023 000	72 014 300		2 46	1 98	1 00	1 25	1 00
Northrop	2 104	4 485 000		1 85	1 50	3 18	0 25	0 25	0 40
Piper	368 000	1 336 000	200 000	0 21	0 27	0 30		0 12	
Republic	15 348 000	10 316 000	18 986 000	1 53	2 58	3 08	0 50	0 50	0 25
Ryan	1 038 000	3 110 000	1 910 000	0 50	1 60	1 30	0 15	0 35	0 35
United	92 006 000	98 077 000	72 423 000	4 35	5 37	5 30	2 00	3 00	3 00
Waco	294 000	816 000	1 235 000	0 64	0 73	0 83	0 30	0 30	0 30

[1] All 1944 figures preliminary [2] Last 8 mo. of 1945 only [3] For fiscal yr. ended July 31 [4] 1945 figures for first 9 mo. only

What Does It ACTUALLY Cost To Fly Your Plane?

PART V OF A SERIES

Carefully considering direct, fixed, and operation expenses—along with the highly relevant depreciation factors—the author demonstrates that in any forthright calculation the upkeep outweighs initial cost, while hours flown afford an outstanding criterion.

By CHARLES A. PARKER,

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IN A COMMERCIAL aircraft operation, knowledge of costs is essential in order to establish a yardstick by which the operator can determine the adequacy of his rates. In the past, many operators have failed to make correct estimates of their costs of operation; they have frequently established rates in accordance with what the other fellow has charged, or upon some arbitrary figure, rather than through use of their own particular factors.

While such procedure may "work out," the truly progressive operator will build better business by employing a more concrete basis upon which to predicate his charges. The operator who handles aircraft sales will be interested in this subject because he must answer questions from prospects relating to cost of ownership by quoting data that are complete and authentic. In the operation of aircraft, the cost problem is similar to that encountered in the use of any other machine, in that total cost of operation per hour varies with the amount of use.

There are certain costs continuing even when the airplane is idle. These may be called "fixed expenses" because they remain constant over a considerable period. They can be considered as overhead when the machine is privately owned and operated, but they do not encompass the overhead which is encountered when the airplane is operated commercially, for then other items must also be considered.

Costs incurred when an airplane is flown may be considered "direct operating expenses," and their total will vary directly with the number of hours flown.

Total costs of aircraft operation are thus the sum of fixed and direct operating expenses, and to determine what it will cost to operate the airplane, a number of factors must be known and others must be assumed to make any reasonable prediction. Direct costs can be reasonably well estimated when local prices for fuel and maintenance are known, from which a figure can be set stating the outlay on an hourly basis. Fixed expenses, however, will depend upon the method of computing depreciation, the amount of insurance, and hangar rent. In addition, any increase in rates of the flyer's personal insurance incurred as a result of owning and flying an airplane should be considered in the total cost of ownership.

Since this last item is of a personal nature, the amount involved will vary considerably with the type of insurance. Accordingly, it will be omitted from our present calculations. Further, where dollars and cents figures are given, they are only for purposes of illustration, though they represent typical values.

Whether you own a rebuilt Army trainer or a new airplane, you still should know what it costs you per hour to fly your own airplane. (photo by Clarity)

Direct Operating Expenses

Expenses incurred when the airplane is flown include charges for gasoline, oil, maintenance, and overhaul. The example given here is based upon some retail figures that might be encountered by a private owner. In considering the cost of commercial operation, wholesale figures would of course be used.

The cost of gasoline and oil needs no explanation. Maintenance costs, in the event of changes in CAR, will probably be lessened. Whereas prewar regulations required that certain checks and inspections be done by licensed mechanics, the owner is now permitted to do more of the work himself. Because of improvements, power plants in the lower hp classes now afford some four years of operation—if we measure with the "yardstick of average use". Not only have these engines stood up well, but top overhaul is now seldom necessary, while the average time between major overhauls has been extended. CAA figures that $0.89 per hour is cost of maintenance, replacements, and mechanics' services for the average lightplane, to which 15% will be added in order to approximate retail costs, which will bring this item to $1.02.

The owner should not overlook the fact that other miscellaneous service expenses may be incurred from time to time. Maintenance costs are not always as low as may be glibly claimed by the aircraft salesman. Addition of equipment to an airplane is not a cost of operation but an increase in the value of the airplane itself.

Table I — Depreciation of Aircraft

Period	Percentage Write-Off	Value in Percentage of Original Price
New	None	100
End 1st yr	20-35	70-80
End 2nd yr	35-50	50-65
End 3rd yr	45-60	40-55
End 4th yr	55-70	30-45
End 5th yr	65-75	25-35

The following estimate is based upon direct cost of flying a typical privately owned 60-75 hp plane:

Gas, 4 gal/hr @ 25/gal	$1.00
Oil ½ pt/hr @ 32/qt	.08
Maintenance & repair	1.02
Total cost per hr	$2.10

Fixed Expenses

Fixed expenses will be considered on the basis of a yearly total, later combined with direct expenses to arrive at the overall expense. Under fixed expenses are such items as the following:

Storage, which goes on regardless of whether or not the airplane is actually operated.

Hangar rents, which may run from $10 to as high as $25 per month. Hangar rent of $20 per month will be considered here, with the airplane on a 12-month "active" storage basis.

Insurance, which will vary from nothing to several hundred dollars. Since an analysis of insurance is not intended at this point, we will consider that coverages are on damage to the airplane (hull insurance), public liability, and property damage. The figure of $322.50 for such combined coverages is a current quotation (Apr. 1, 1946) on an airplane costing $2,400.

Depreciation, which is present from the day an airplane is purchased until its eventual disposal. In the course of time, the private airplane owner will sell his machine for price less than he originally paid for it, and the loss will be part of his operating expense. If the owner be an operator, he should have made an allowance for this depreciation, and in so doing have created another asset (cash) that will enable him to make a replacement without capital outlay.

Table II — Cost Per Hour vs. Hours Flown

Hr. Flown	Fixed Expense	Direct Cost	Total Cost	Cost Per Hr
10	$1 042 50	$21 00	$1 063 50	$106 35
50	1 042 50	105 00	1 147 50	22 95
100	1 042 50	210 00	1 252 50	12 53
200	1 042 50	420 00	1 462 50	7 32
280	1 042 50	735 00	1 777 50	6 08
500	1 042 50	1 050 00	2 092 50	4 18
750	1 042 50	1 470 00	2 512 50	3 50

Figuring Depreciation

Straight line method. By this system, the airplane is depreciated on the basis of a certain number of years of useful life. The Bureau of Internal Revenue indicates that a 5-yr. writeoff for private aircraft is acceptable, however, at the end of that time the airplane most certainly retains a residual value. A steep writeoff is unnecessarily hard on an operator. In fact, CAA considers a period of 10 yr as fair, because it more nearly accommodates the actual situation. The average life of non-scheduled civil aircraft has been 7.4 yr, including destruction as a cause for cessation of use.

Writeoff on an hourly basis. This method, which predicates a certain working life, and which becomes a straight-line method with regular use, is not recommended unless the plane is used on a uniform basis over a long period.

Declining balance method. This type of writeoff based on a lessening percentage of original value, more nearly gives the true worth than the other two systems. Here, the values tend to keep pace with the market prices. With the introduction of yearly models, airplane values tend to depend more upon age than upon the number of hours flown. The plane does not, however, depreciate at a fixed annual percentage.

To explain: The highest percentage is deducted in the first year of the craft's life, with a gradual lessening of this amount as the plane grows older. Hence, at any time the plane will have some value. The method is similar to that found in both the automobile and the machinery fields. An actual case will be of interest—

The plane in question originally sold for $7,000. It was flown for only 40 hr., then remained in dead storage for 2 yr. At the end of that time it was sold for $3,600—slightly more than half of its original value. Had this airplane been considered on the basis of an hourly writeoff, it would have decreased but little in value. If it had been depreciated on a 5 yr. basis, it would have shown a value of $4,200 at the end of 2 yr., while on the basis of 10 yr. it would have shown a paper value of $5,600 at the time of sale. Obviously, these last two figures were not in line with the market, but the interesting point is that the plane would probably have brought almost as much had it flown 140 hr. or even 200 hr. as it did at 40 hr.

In one recommended practice, the airplane was considered to depreciate in 5 yr. to approximately one-third of its original value. Writeoff here would be one fifth of the difference, or about 13⅓% per year. This again gives a straight-line depreciation for the first 5 yr. and appears slightly low for the first year if a yearly change in models should become customary. In this accounting, an operator may decide to use the 5-year writeoff basis. But in sales he should use the percentages given in Table I, since careful determination of depreciation and market price then becomes essential.

Total Fixed Costs

On the foregoing basis fixed costs for the first year would be:

Hangar storage @ $20.00/mo	$240.00
Insurance (hull, public liability, property damage)	322.50
Depreciation @ 20% (on $2,400 plane 1st year)	480.00
Total fixed costs	$1,042.50

Total Cost of Operation

We can now estimate total cost of operation by the following formulas. Total cost of operation = fixed expenses + direct operating expenses, while the cost per hour is obtained by dividing fixed expense by hours flown and adding

Table III — Effect of 50% Reduction In Storage and Insurance Rates

Fixed Cost / Flight Hr	Direct Cost / Flight Hr	Reduced Cost Per Hr	Former Cost Per Hr	Percent Saving Over Former Cost
761/200 = $3 80	$2 10	$5 90	$7 32	19 3
761/350 = $2 17	$2 10	$4 27	$5 08	15 9

Table IV — Comparison of Operating Costs

Flight Hr	Lightplane	Plane A	Plane B	Plane C
100	$12 33	$16 17	$20 82	$25 12
200	7 02	10 92	17 07	20 87
350	5 58	8 17	11 62	14 34
500	4 18	5 87	8 32	11 34

Lightplane is type already discussed.
Plane A is 90-hp. 2-place 110-mph., costing $4 000, direct exp. $2 67/hr., fixed $1,650 yr.
Plane B is 145-hp. 4-place 120-mph., costing $7 000, expenses $4 32 and $3 540.
Plane C is 245-hp. 4-place 140 mph., costing $8 000, expenses $8 02 and $2,820.

Table V — Cost Per Seat-Mile for Various Size Planes

Type	Cost Per Hr Cruising Speed	Cost Per Mile	Cost Per Mile No. of Seats	Cost Per Seat-Mile
Lightplane	$3 08 / 90	3 6c	3 6c / 2	2 8c
Plane A	$8 17 / 110	7 4c.	7 4c / 2	3 7c.
Plane B	$11 62 / 120	9 7c.	9 7c / 4	2 4c.
Plane C	$14 34 / 140	10 02c	10 02c / 4	2 5c.

direct hourly cost of $2 10 in each case.

Cost per flight-hour is reduced materially as the amount of flying is increased. This cost reduces most rapidly during the initial hours, with a gradual lessening to the point where there is but little reduction, even with a large increase in the number of hours flown (the period from 500 to 700 hr. for example). For full appreciation of this reduction of the cost of operation, note the figures in Table II.

It can readily be argued that expenses of the private plane rise high with low usage. The type of a plane upon which these figures are based can be hired for from $6 to $10 per hour. With $8 taken as an average, it could be said that up to nearly 200 hr. it would be cheaper to fly on a rental basis than to own.

Comparison of Costs

It is obvious that once hangar rents and insurance coverages are materially reduced, not to mention the initial cost of aircraft themselves, private ownership will become much more attractive than at present. With a 50% reduction in storage costs and insurance, for example, the fixed expenses would be reduced from $1,022.50 to $761 for the year and then comparative costs for 200 and 350 hr. per year would run as in Table III.

A more favorable presentation of costs could be made on the basis of the down and no insurance, but most owners prefer to store their airplanes, and lack of insurance protection is not sensible economy.

The foregoing discussion has revolved around the lightplane, but what of the larger aircraft? Three types of airplanes, in addition to the lightplane already considered, are compared in Table IV.

The substantial costs involved indicate the need for the operator to analyze income possibilities carefully before investing in larger and more expensive aircraft. On the other hand, when assured of regular usage and sales on a "per seat" basis, it is interesting to find what a favorable showing larger aircraft can make.

This is evident in Table V where a usage of 350 hr. per year has been taken for illustration. Particular attention is called to the favorable cost per seat-mile in the case of larger craft. To enjoy such an advantage all the seats would have to be occupied.

The advantage of parties chartering larger aircraft for round trips is also brought out in Table V. Three persons flying cross country with a commercial pilot would still enable a rate of 3.4c. per seat mile for the largest plane shown, making favorable comparison with the average airline fare of 4c per mile. For a private owner flying his own airplane with all seats occupied, the rate of 2.5c per seat-mile for the largest aircraft would apply, making an even more favorable comparison.

A final point in connection with costs is that of rate reductions with increases in cruising speed, other factors remaining constant. Take the case of the lightplane. With an increase in cruising speed of from 90 to 122 mph. (about 20%) there would be a reduction in cost from 3.8c. to 4 6c. per mile, or more than 1c. The interesting possibilities of lowered costs, attendant with the challenge to the manufacturers, can be fully appreciated when reductions become possible through the lowering of insurance and storage rates, as well as through increased performance. At present, fixed expenses constitute one half of the total expense up to about 500 hr. of flying. This situation must be improved if aircraft ownership is to become widespread.

It is not uncommon for the aircraft salesman to be asked for a comparison of aircraft operating costs with those of other vehicles. An excellent analysis, developed in 1938, enables some revealing comparisons to be made (see Table VI). Two types of aircraft were chosen in the class of planes A and C of Table V. A 35-ft. motor boat and also a motor car were then brought into parallel. Charges for fuel, storage, and repairs were made according to costs current at that date. Depreciation was calculated for the planes and car at 25% and for the boat at 15%. Insurance charges were below those used in the preceding discussion. (These variations are not important, because as long as conditions are as similar as possible and in line with current usages, the comparison will be of value.)

It was assumed that the planes were used on trips of 50 mi. or more, while operation of the car was based upon suburban travel including trips up to 50 mi., and use of the boat was judged as being in the short cruise and harbor spin category.

Particularly favorable is the per-mile comparison between the small plane and the car. The striking operating-cost differences between aircraft and the yacht should be valuable data to every aircraft salesman. Not many persons engaged in aviation realize that such considerable variances exist between these two specific units.

Little in the way of a hard and fast statement can be made that aircraft are cheaper to operate than this vehicle or that one, because much depends upon the factors involved, and upon the basis on which comparisons are made—i.e., mileage, the hourly basis, or the per seat basis.

The salesman should exercise caution when it comes to making statements about the cheapness of aircraft, or else he may find himself in an embarrassing situation, though it is evident that there are extremely favorable situations for comparison and that there are types of operation in which the plane is predominantly suited for performing a certain activity at a favorable cost level.

Table VI — Cost Comparison Between Aircraft, Automobile, and Motorboat

	Aircraft (90 hp.)	Aircraft (245 hp.)	Automobile Sedan	Motorboat 35-ft. Cruiser
Value	$3 864	$8 000	$3 020	$8 000
Use/Yr.	450 hr.	450 hr.	11 250 mi. at 25 mph. (300 hr.)	1 800 mi. (150 hr.)
Cost/Hr.	$5 63	$11 53	$3 98	$13 23
Cost/Mi.	3c	2 2c.	13 9c.	$1 10

HIGHEST SEAPLANE BASE TURNS AWAY BUSINESS

By EDWARD E. THORP, *Assistant Editor, Aviation*

Despite gloomy forebodings from fellow pilots, Wes Stetson based his Taylorcraft floatplane 6,200 ft. above sea level—and found business already waiting for him.

WHEN WES STETSON returned from trans-Atlantic flying for ATC he decided to start his flight school where he would not be crowded. Lake Tahoe, Cal., one of the most beautiful lakes in the U. S., seemed to be unique among the few eligible sites still overlooked by operators, so he selected this body of water as his seaplane base.

Remembering that the lake is 6,200 ft. above sea level, Stetson decided to make a few inquiries about the experience of others who had tried flying off the surface of this body of water. First impressions were not encouraging—two amphibians had required dismantling to get them away from the lake. And while Frank Fuller had taken off successfully, he was flying a twin Wasp Grumman.

"Everyone was very good about giving information," writes Stetson, "but I could always detect that look they reserve for a fellow pilot who isn't considered to be using all his marbles!"

Finally, after considerable trouble, a Taylorcraft on Edo floats was obtained and flown from Oakland to the lake. The altimeter stuck at 10,000 ft., but the plane kept on climbing and seemed to have plenty of power, so Stetson decided to take a chance and "set her down" on the water. Everything worked out okay, except that it was found very difficult to visually estimate altitude above the clear, glassy water.

The resort of Nelson Salter, at Emerald Bay, was selected as a base—and business came in as soon as people saw the seaplane on the water. Though this was a flying school, the demand for charter flights could well have led to a running business in itself, but unfortunately, gasoline restrictions prevented this branch from being developed at that time—1944.

So far as takeoff was concerned, there was no trouble from plane, floats, and engine, though both Stetson and his instructor, Glenn Anderson, weigh over 180 lb. Only difficulty was that which is experienced no matter what the altitude—that is, taking off from flat water. With a full tank and two persons in the plane, it was necessary to rock one float out of the water until the ship was riding on only one step, after which there was no difficulty in leaving the surface.

Being the only air operation on the lake, at a resort where nearly everyone has money, there was no trouble in keeping busy for as long as the pilots could stay flying. At $10 per hour there was a waiting list throughout the summer.

Nelson Salter's resort at Emerald Bay on Lake Tahoe, Cal., is Wes Stetson's high up summer base.

Dock for float repair was made by mounting plank platform on old oil barrels. This is the only part of the operation remaining from one year to next.

Problem of what to do about winter storage was simply solved—the plane was sold to a summer resident who had learned to fly and wanted to return home by air. Each summer Stetson takes up a new plane, thus solving the maintenance and overhaul difficulty neatly and profitably. The only piece of equipment which is left behind at the season's end is a dock, which was constructed on old barrels at a total cost of less than $50.

There must be many locations in this country and Canada where an operation of this type could be profitably carried on. Given a good plane of almost any of the standard makes, altitude seems to be no bar to operations, this being proved by the fact that Stetson also carried on successfully from nearby Fallen Leaf Lake, which is at least 100 ft. higher than Lake Tahoe.

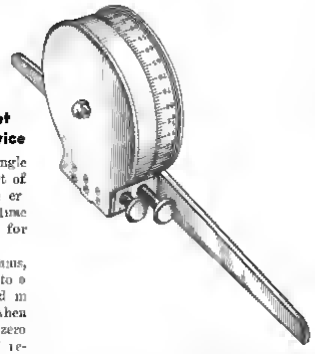
WAYS & MEANS

Prop Blade Angle Measuremeot Sped by Grevity Operated Device

• Designed lo give propeller pitch angle readings without calculation on part of mechanic and without accumulative errors, this instrument, used for some time by USN, is now being produced for civilian use.

Unit consists of two narrow drums, mounted on ball bearings attached to a straightedge. Drums are calibrated in degrees and are so weighted that, when free to move, they will turn with zero marks uppermost and together, if restraining brakes are released by pressing on buttons which control them.

When using instrument, a propeller blade is moved into a horizontal position, then straightedge is placed across blade surface at a predetermined point. Brake is then released on one of weighted drums, which turns freely until zero mark is uppermost. This drum is then locked by releasing brake button.



Propeller is then rotated through 180 deg., bringing it into a horizontal position opposite to that which it formerly occupied. Straightedge is then placed against same place on blade as previously and brake on other drum is released. Second weighted drum thereupon turns with its zero mark at top, after which brake is applied. Difference between two zero marks on drums indicates angle between two positions of blade surface. Because this angle is twice actual pitch angle of blade, one drum is marked to read in graduations of two degrees spacing, so that direct readings of blade angle can be made.

Apart from advantage of direct reading without calculation or recording of figures, instrument permits making of pitch measurements without leveling plane or fixing a datum line from which a horizontal center line can be established.

C. G. Shifter Shortens Landings

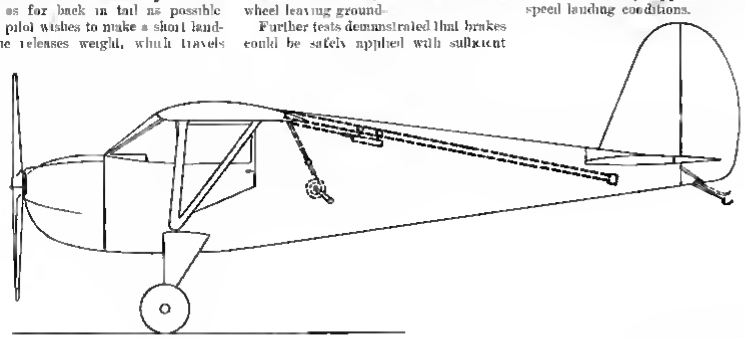
• A new accessory made by Aircraft Devices, Philadelphia, has been designed to provide that small amount of extra tail loading necessary to prevent nosing over when a short runway compels pilot to apply his brakes heavily while still traveling at high speed.

Device consists of a weight, mounted on ball bearings running on a track which extends from C.G. of plane to a point as far back in tail as possible. When pilot wishes to make a short landing, he releases weight, which travels back along track to tail, thereby changing position of C.G. of plane. Because this change makes plane tail heavy, it is necessary, before landing, to depress elevators as far as possible, thus adding to retarding effect of brakes.

Tests made before CAA and NACA officials at Wings Field, Ambler, Pa., showed that test plane—a Luscombe Silvaire, which lands at 52 mph.—could be set down and completely stopped within a 100-ft. dia. circle without tail wheel leaving ground.

Further tests demonstrated that brakes could be safely applied with sufficient force to skid wheels on dry turf. Craft also took off repeatedly with weight in rear position, this test being made to prove that takeoff could be accomplished successfully without need for bringing weight forward.

Having a total weight of 16 lb., device both lowers and moves backward C.G. of plane, so that forces tending to overturn craft act with approximately half overturning moment normally present when brakes are fully applied under high speed landing conditions.



New CAA Flight School Manual

Operators interested in bringing their flight school facilities up to standard should request CAA Manual 50 on flying school rating.

Noteworthy in manual's provisions is liberalization on runway length down to 1,500 ft., only condition being that school planes be able to take off in half length, yet clear usual 50-ft. imaginary obstacle. This ruling eases cost for new airport projects, where expense of leveling long runways is major outlay. Also specified is 20-to-1 glide angle for approach.

It should be remembered that Administrator T. P. Wright states CAA has no power to compel a school to comply with its standards. Those which do not comply are generally of too low a standard to obtain CAA approval.

* TAGGING THE BASES *

First Region—Simsbury Flying Service has leased hangar at former AAF base, Bradley Field, Conn. . . . Atlantic Gulf Midland Corp., Nutley, N. J., has purchased Douglas C-47 for use as textile transport to Puerto Rico. . . . DuPont Airport, Wilmington, Del., is now being operated for civil flying by Stewart E. Poole. Atlantic Aviation Service . . . Alton B. Sherman has re-opened Hyannis Airport at Cape Cod, Mass., and NEA stops there on Boston-N. Y. flights. . . . Earl Goekeler has completed runways at Martin Medford Airport, Moorlton, N. J. . . . Merrimack Valley Air Service, Lowell, Mass., is operating airport and seaplane base. . . . Metropolitan Glider Assn. recently held first postwar reorganization meeting with Charles H. Gale elected as temporary chairman (see photo). . . . R. von Seinfeld has organized Atlantic Airborne Sales Co. at Huntington, L. I., N. Y., to operate airport there. . . . Gillett Welles-Welles Aviation Corp., Elmira, N. Y., will give ground school and flight courses at Elmira College next Fall. . . . New England Central Airways, with office at 280 Beacon St., Boston, has been organized to operate airports in vicinity of city.

Second Region—Clarence W. Ludwig, St. Petersburg, Fla., is first pres. of Florida ATA. . . . Fairforest Airport, Spartanburg, S. C., has been opened by Messrs. Moss, Ginn and Brown. All former Ola Field has two 2,300-ft. runways, 425-ft. multiple T-hanger, and brick shop. . . . E. O. Shealey is now mgr. of Newberry, S. C., Municipal Airport. . . . Titusville-Cocoa, Fla., is raising funds for construction of municipal airport.

Third Region—Minnesota Commissioner of Aeronautics L. L. Schroeder states that following communities are planning airport improvements: Ortonville, Park Rapids, Fergus Falls, Marshall, Winona, Owatonna, Detroit Lakes, International Falls, Hibbing, Alexandria, Cook, North Come., Grand Marais, Crookston, Pipestone, Worthington, Redwood Falls, Faribault, and Thief River Falls. . . . Aero Corp., Atlanta, Ga., is new member of NATA. . . . Harrington Air Service, operator of Municipal Airport, Mansfield, Ohio, has built $125,000 restaurant and Sky Club with glassed-in flight deck for members (see photo). . . . Evansville Sportsman Pilot's Club, Ind., has resumed operations under leadership of V. Q. Hobgood, pres.

Fourth Region—Texas Air Lines has started operation under Mgr. Cyril P. Erwin. Erwin, Newman Co., Houston, Tex. Line connects that city with others in neighboring states. . . . Phoenix, Ariz., ran aerial cavalcade to number of cities in state, crossing Mexican border for welcome at Nogales, Sonora by Governor Gen. Abelardo Rodriguez. Group was led by Bill Morel, flying his con-

(Continued on page 50)

Conferees who attended first postwar meeting of Metropolitan Glider Assn., recently held at McGraw Hill Bldg., N. Y. C. Temporary committee (front row, l. to r.) are Charles H. Gale, Conn., chairman, Larry Lawrence, N. Y.; E. Thorp, N. Y.; Alexis Dawydoff, N. Y.; Lewis Hull, Pa.; Gus Raspet, N. Y.; Gus Schauer, N. J., and Don Lawrence, N. J. Thames Naire, N. Y., another committeeman, was not present.

This $125,000 Sky Club at Mansfield Municipal Airport, Ohio, features second story flight deck commanding extensive view of field and surrounding country.

Lineup of over 100 planes at Palm Springs, Cal., during recent visit of Los Angeles Jr. C. of C.'s breakfast flight group. Types of craft varied from 65-hp. lightplanes to Lockheed Lightning seen in foreground.

AS THE OPERATORS SEE IT

Maybe you've run into o sales ond service snog, face some overhoul hurdle, ore grappling with a flight teaching tongle, or seek guidonce in the moze of maintenance. Whotever the perplexity, it's "fair shooting" here in our operators' corner. Answers, ond criticisms of answers, will be paid for at AVIATION'S usual rates. Welcome, too, will be photos or sketches which "point up" the problems.

QUESTION 3—*Which of these sources of new business do you consider best: (A) Customer goodwill, (B) billboards, or (C) local newspaper advertising? What has been your experience with these media? Have you used successfully any other method for attracting business to the airport?—D. H.*

Answers: "All three methods have their place and are most effective when used in combination. At this airport, we have the only swimming pool in the district, and we use billboards within a 10 mi. radius to tell tourists about it. When they stop for a cool dip, we sell them the idea of flying down the road for 40 or 50 mi. to choose the best scenic route for the motor trip. They then tell others whom they meet, and here the transient goodwill comes in. And for local trade, nothing brings more return than customer goodwill, but newspaper ads and notices bring quick benefits when we have something special to offer—a new model plane or a second hand bargain for quick disposal. We get local newspaper publicity in exchange for flying the editor to neighboring towns when there are newsworthy happenings. Since someone from the airport would go in any event, to make fresh contacts, this newspaper publicity costs very little, and our local editor not only boosts our (he calls it "his") airport, but also introduced us to many prospective customers."—*L. R. Regan, Segundo Airport, Penn., N. M.*

Readers Are Invited to Answer—

Question 4—In the initial step of our fixed base set up, we are confronted with the problem of site expense. Do you consider that a main highway passing an airport is of sufficient advantage to compensate for the relatively high tax charges on the land as compared to a location on a secondary road where there is little through traffic but where taxes are considerably lower? —A. M.

TAGGING THE BASES

varted Lockheed P-38 . . . Dallas Aircraft Salas reports Premier Oil & Refining Co., Kilgore, Tex., has purchased twin-engine Beechcraft, to be piloted by Kenneth Koeling . . . Walter Menge of Leon Valley Airport, Tex., reports more than 50 planes now based at field, much of business coming in from Mexico . . . Oklahoma Aviation Assn. held first postwar meeting recently.

Fifth Region—Flying Farmers of Kansas held first organization meeting at Hutchinson under sponsorship of "Kansas Farmer Magazine"; over 200 planes being flown in . . . Missouri Aviation Corp., Kansas City, has discontinued supply business. . . . Distributors for Globe Swift: Norbart Locke, Dodge Airways, Des Moines, Iowa; Edgar Smith, Kansas City Flying Service, Mo.; Kranz Airways, Omaha; L. W. Mack, Denver; Kranz Airport, St. Louis; Ralph Hubbard, Watertown, S. D.; and Ossorgin Aviation, Reno, Nev.

Sixth Region—Philip Smookler and Eugene Kenwarthy have opened new airport at San Ramon Valley, Ia. ha operated in conjunction with their sales agency at Berkeley. . . . Los Angeles Jr. C. of C. organized successful breakfast flight to Palm Springs, Cal., on Apr. 28, flying 104 planes (see photo). . . . Delano, Cal., airpark has been approved by 3-1 vote of local board. . . . Buchanan Field, Concord, Cal., with two 5,000-ft. runways, is now being operated for civil flying with Darrell Jensen as mgr. . . . San Bernardino County, Cal., has appointed aviation advisory board consisting of five local operators: Les Farrar, San Bernardino; Joseph Brier, Tri-City Airport; Dewey Cable, Cable-Claremont Field; George Sanford, Ontario Municipal Airport; and Wm. Natte, Needles Municipal Airport . . . Bob Metcalfe and Slim Dever are now operating Link trainer and instrument school at Oakland Airport . . . John H. Engel, Escondido, is establishing residential subdivision and locating auto and farm equipment businesses alongside his 5,000-ft. landing strip . . . San Lorenzo Flying Club has been organized at Hayward Airport, Cal., members paying $50 each thereafter flying for $3 per hour . . . Millar Druckel Aviation, Van Nuys, Cal., is distributor for Nelson Soaring Plane and Republic Seabee in southern Cal. and Ariz.

Seventh Region—Boise, Ida., has new airport at Blackfoot Island on Snake River. Tucker Airport at Blackfoot will be discontinued . . . New airport construction in Idaho is reported at Shoeshona, Bancroft, New Meadows, Council, Craigmont, Bonners Ferry, Downey, Grace, Albion, Cambridge, Nez Perce, Collonwood, and Genesee . . . Oregon Aviation Assn. was organized at May 7 meeting at Rand. . . . Horseshoe Flying Club has been formed at Port Orchard, Wash., by R. Bill of Bremerton, and N. E. Little, R. F. Bill, and C. M. Peterson of Port Orchard.

Canada—Quebec Airways has been formed at Seven Islands, P. Q., for charter flying. Company will fly hunters and and fishermen into interior . . . Seaplane base is now being operated at Toronto Island Airport, Toronto.

Real Sales Clincher Is the Follow-Up

By K. H. HOLMGREN, *Advertising Engineers Corp.*

Tenacity is a sorely needed requisite in the scheme of aviation merchandising. So counsels Author Holmgren, who declares that the dealer might well keynote his pursuit of profits with the paraphrase, "Faint heart ne'er won fair sale."

THE WEARING OF THE GROOVE
Oh well, I'll try him again tomorrow

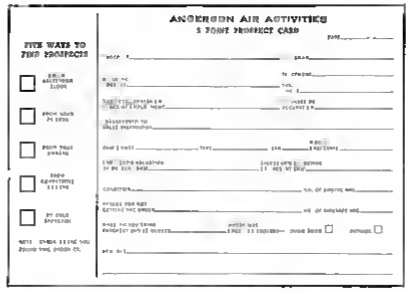
AN AVIATION DEALER calls two strikes on himself when he does not take the time to follow up direct sales leads—those furnished him by the manufacturer, those developed from his own advertising, or those offered by students and visitors at the field who evidence real interest by owning a plane, taking a flight course, or even going for a short pleasure hop.

A lot of money is spent on advertising every year by aircraft makers and airport operators. This investment, made to create consumer acceptance and good will, is justified only if action is taken to develop customer interest into actual sales.

There has been gross neglect in attending to inquiries received as a result of advertising. Airplane sales leads, for example, are normally received by the factory and consequently are passed on to the distributor and then to the dealer. A common dealer complaint is that many of these leads are merely from surrounding youngsters and other people who currently have no reasonable use for a plane. This may be so in some cases, but the dealer can't be *certain* unless he follows up each inquiry personally and persistently. Too many fool themselves out of sales by saying, "No use making a call on this prospect—I know that he isn't in a position to buy now."

Such fallacious reasoning is one of the greatest "deflectors" to successful selling known to the aviation industry. Too often the new or untrained airplane salesman is enthusiastic and effective only on his first call. Finding the prospect lacking sufficient ready cash for an outright purchase, the salesman does not

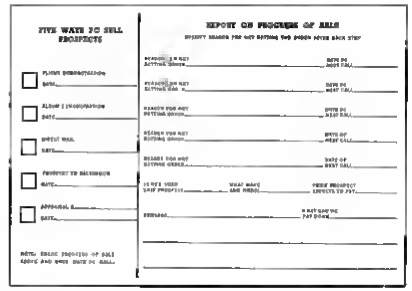
(*Turn to page* 147)



ANDERSON AIR ACTIVITIES
5 POINT PROSPECT CARD

FIVE WAYS TO FIND PROSPECTS

A special sales-card is a valuable part of an effective follow-up system. Above is shown both sides of card used by Anderson Air Activities of Milwaukee. This convenient 4x6-in. form not only lists ways to get prospects and sell to them, but also provides a comprehensive check on sales progress. And when kept readily accessible, it helps to serve as an "anti-deflector" by encouraging persistence.



REPORT ON PROGRESS OF SALE

FIVE WAYS TO SELL PROSPECTS

New Techniques Nullify Static

Just revealed, these methods developed by military services and airline help keep aircraft radio interference-free when contact is most necessary.

NULLIFICATION OF ELECTRICAL charges generated on aircraft can now be accomplished by four techniques developed by the Army-Navy Atmosphere Electricity Project, in cooperation with Northwest Airlines, following tests conducted at Wold-Chamberlain Airport, Minneapolis.

Just released from military security, these techniques include: Use of wick dischargers (such as shown in accompanying illustration), covering of receiving antenna with polyethylene, location of antennas away from discharge points, and designing of aircraft so as to avoid discharge points.

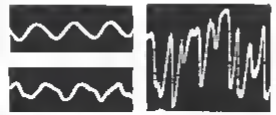
The first two methods, which are applicable to existing planes, reduce interference to such an extent that Northwest will employ them as soon as production models of the necessary units are available. The latter two, although desirable from an electrical viewpoint, cannot always be reconciled with constructional and airflow requirements.

Precipitation static, a major cause of noise in aircraft radio receivers, is generated when planes fly through air laden with such particles as ice, dust, or snow, or when they pass close to electrically-charged clouds, such as thunderheads. Friction of the particles against the aircraft surfaces, or movement of the plane through electric fields set up by charged clouds, generate electric pressures which often exceed 100,000v. This pressure, after it becomes high enough, causes the familiar St. Elmo's fire or corona, which forms at wing and propeller tips, on antenna masts, and even along aerials. This corona, which causes radio interference, can be reduced by (1) draining off the electric charge while it is still so small that it causes but little interference, or (2) actually preventing it from forming where it could cause interference.

To drain the charge, the project engineers developed wick dischargers, which consist of metal ribbon and fiber cord. The many small sharp metallic points of the wick permit the charge to leak away at low electrical pressure.

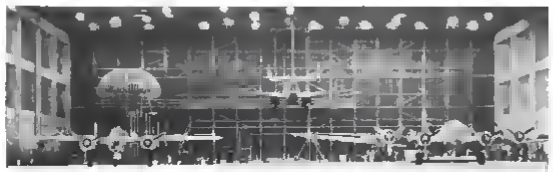
Corona can be reduced either by using a larger antenna wire or wrapping the wire in polyethylene. Corona on wires, struts, and antenna masts can likewise be prevented by covering them with polyethylene, provided wick dischargers are also used to prevent pressure of the charge from becoming too great. The charge will, however, be generated no matter what is done.

Using the 1,000,000v. generator developed at the University of Minnesota to determine the parts of aircraft at which corona appeared, the project engineers found it formed at all small radius edges, called discharge points, with those near the receiving antenna being particularly objectionable. From their tests, they recommend that, wherever possible, receiving antenna should be located away from sharp edges; antenna should be of large diameter wire, and sharp edges should be avoided. Such design practices will reduce corona, but wick dischargers must still be used to provide low pressure drainage paths for charges that are unavoidably generated on planes.



Oscillograms (above) show how polyethylene insulation on receiving antenna reduces noise. Left top photo shows signal with no noise; right shows how precipitation static obscures test signal; bottom left shows how polyethylene on antenna reduces noise so that test signal can be distinguished.

Closeup of wick discharger (left) developed by Army-Navy Atmosphere Electricity Project in cooperation with Northwest Airlines. Composed of metal ribbon and fiber cord unit, it drains off electric charge at low pressure.



For purposes of measurement, electrical static encountered in flight was duplicated in this hangar-laboratory located at Wold-Chamberlain Field.

SIMPLIFYING PERSONAL PLANE DESIGN

PART I

By RALPH H. UPSON, *Consulting Engineer*

On a previous series, "Designing Tomorrow's Personal Plane,"* dealt mainly with what might be called the one-way or the other type problem—should the wing be high or low, cantilever or strut braced, should the landing gear be retractable; should the engine be tractor or pusher?

Now we come to those problems of proportioning and degree, demanding not a choice of alternatives, but an optimum point from an infinite series of possible values and combinations.

These are problems having their best approach in a mathematical representation of the governing conditions, tempered by experience and checked by such further experiment as will assure a practical solution. And such experiment must itself be guided by sound "theory"—or else by pot luck—if the result is to be of more than passing interest.

Generally speaking, wind tunnel, structural, or flight tests, important as they are, can only *check* the final answer. They cannot *produce* the answer, except through a test program so extensive as to be outside most budget possibilities. To handle these problems to the best advantage, requires the utmost simplification of design procedure.

A good analogy is the trend toward simplified control—really a case of simplified design. Many and ingenious have been the arguments against it. But despite open questions remaining as to ways and means, the major objects of simplified control now seem to be generally accepted. Will a proposal for simplified design *methods* be the signal to start another long and futile argument?

It seems hardly possible. Yet the superman complex dies hard. As an ardent horseman seeks a spirited, unruly horse to try his skill, and as a professional pilot gets real satisfaction from flying a plane that "has to be flown", so a good engineer welcomes an obstruse or involved problem worthy of his specialized skill—an understandable if not commendable sentiment, but wrong nevertheless.

A New Airplane is Conceived

The president of an aircraft company calls in his sales manager, production manager, and chief engineer, and says to them: "Our board of directors has decided to put out a new lightplane with maximum appeal to the present market. Its characteristics will be for us to decide." Then, with a hopeful look in the general direction of the sales manager, he asks, "What are your recommendations, gentlemen?"

Not being exactly of a retiring nature, the sales manager, with a side glance at the engineer, speaks up in no uncertain terms: "It must definitely be the safest, cheapest, and best performing plane in its class." And, as something of an afterthought, but still important: "The flight tests should be finished, and we should have our A. T. C. and be ready for production within six months."

"How about it?" asks the president, "Can we do it?" "Sure we can," puts in the confidence inspiring production manager, "if this guy will just give me the drawings. But they've got to be right—a quarter the usual number of parts, and no expensive gadgets or tooling."

Since it's the very first time that "this guy," the engineer, has heard of the proposition, he has meantime been doing some quick thinking. No room here for any radical change of type; that's out of the picture. So the improvement will have to be wrapped up in the detail design. But that still takes time. Fortunately he has some improvements already on the fire—the kind of fire that perpetually burns in a good engineering office—and he knows his job. His remarks are not too discouraging.

"Well," he begins, "in six months you can have a dressed-up version of our present model; while in nine months you can have some real improvements, with sales points worth talking about—but still just another airplane. Why not put in a few months more and do a *real* job, one that we can be proud of, that will really go to town?"

The final decision, as may be guessed, is to take the dressed up version, drop the intermediate one, but be working along on the more advanced design. Worse and worse! Instead of one job, difficult enough in itself, the engineer has only succeeded in talking himself into two. He frankly expresses his skepticism as to how much can be accomplished on the advanced design while accelerating to the utmost the model of immediate interest. He leaves the president not quite convinced, however, as to why a little progress takes so much time.

Now let's be honest about it and admit that maybe the boss has something there—that his attitude is at least partly

Ralph Upson's recent series in "Aviation" proved so popular and so valuable to the industry that we joined many engineers in asking him to continue his stimulating discussions on personal plane design. Here he compliments dealing as he says with those problems of proportioning and degree"—which are often among the most perplexing. And with his usual thoroughness he makes available for creators of personal aircraft what literally amount to new engineering tools—for with each article he will present sound, workable formulas which can be employed in the tough, everyday work of designing new and better airplanes. We will set these formulas up so that they may be most easily and readily used as the efficient tools they are.—The Editors.

*June, 1945, through March, 1946. AVIATION.

justified. Efficiency is a word commonly batted around the engineering department, but before any other kind of efficiency, there must come *engineering* efficiency—which might be defined as the ratio of knowledge-used to knowledge-available.

If some quantitative measure of such efficiency were possible, its fluctuation over the years would be interesting to follow. But even without a quantitative basis, most observers, certainly including the engineers themselves, would probably agree that lightplane design, although improving, still employs only a small fraction of available knowledge, still lags ten years or more behind the possibilities revealed by scientific research. Here we are speaking not of methods or features which, after due consideration, have been dropped for economic or other sufficient cause, but of those which are summarily rejected or missed entirely.

Engineering Department Troubles

There are of course extenuating circumstances—scarcity of time and experienced personnel, problems of standardization and scheduling; the routine labor of computing, drafting, and checking; the inevitable "bugs" in new design; and just ordinary human inertia. The plain truth is that the project engineer, responsible for practical design, is not primarily a scientist, and we cannot expect him to be one. He must use the results of scientific research, but instead of concentrating on a scientific problem, he must coordinate and apply a multitude of often-conflicting results from theory, tests, and practical experience. He must produce numerical calculations and/or new tests of his own to justify the proposed design.

The engineer in charge must not only meet a schedule and a budget in his own department, but often must take the chief burden of responsibility to prove that the plane can be economically produced and operated. And considering that the primary responsibility of the engineer is to make his stuff work, it is certainly no reflection on him that he as often misses features that could be made landmarks of progress. Under the conditions imposed, such as in the case here cited, he must for the most part follow well marked tracks and avoid excursions into unknown territory.

The engineer's problem in general involves dealing with the ever-increasing demands beyond strict engineering requirements. Means of coordinating design with production appear to be rapidly approaching a satisfactory state of affairs. Here there is usually at least a close physical relationship, a chance for direct give and take, and an obvious relation of cause and effect. Not so, the coordination of design and research, where at most only a small part of the pertinent research is directly associated with the design project that has the current priority.

Most of the research-based information, along with its optimum use and associated factors of judgment, must be accumulated through long study, experience, and outside contacts. Keeping up with all the current technical literature can readily be a full-time job in itself, and as these incidental requirements are constantly increasing, it is no wonder the normal design engineering staff is hard-pressed to do more than serve immediate requirements.

It is obvious that one key to a broader engineering coverage is to save time and costs on the routine tasks that make up such a large part of any new design project. Of course the easiest way to do this is to pick conventional numbers more or less out of a hat—power, rpm., and propeller size, wing loading, aspect ratio and the other ratios; taper, thickness, camber; dihedral, twist, sweepback, slots and flaps, fuselage and tail proportions, control and landing-gear characteristics—not to mention all the internal variables of structural importance.

Does anyone seriously expect to get a superior or even acceptable new design that way? "Oh, no," it may be said "we check everything either by calculation or by wind tunnel and structural tests." But an engineering check—like shop inspection, a very necessary function—is at most only insurance that you get what you specify. In other words, if you're asking for "just another airplane," that's what you get.

"Sounds like sense to me—you find the answer on paper, then you check it with wind tunnel tests."

We revert then to the problem of devising more efficient means for handling and properly proportioning the design as a whole. It is here that there is apparently the greatest opportunity for saving time of the real engineering personnel, those who can *use* that saving to the best advantage. For the individual, it means a job instead of a grind, and perhaps the opportunity to follow up that idea he has so long dreamed about, but has had no time to get at.

The Empirical Approach

Any effective, yet sound method of simplifying the design process seems inevitably to mean some kind of empirical representation. Why empirical? In the first place, the average engineer has little time among his many duties to set up conformal transformations and Fourier series, solve differential equations, or perform many other tasks which, for the research scientist, are proper and necessary. Whether to save time in work done personally by the engineer, or to permit such work to be done by relatively untrained personnel, the right kind of empirical simplification pays off in either case.

In the second place, progress would largely come to a stop if we could not consolidate, simplify, and put into practical form each step as we go along. Take, for example, the Glauert method of calculating spanwise lift distribution, or the more straightforward but still too complicated Lotz method; they served their purposes well in reliably establishing, as confirmed by test, a theoretical foundation for solution of this specific problem.

Such solution, however, like others of its kind, is not an end in itself, but must be used as a stepping-stone to other results, such as the optimum coordination of lift, drag, weight, and control characteristics for a given purpose. Unless such calculations can be simplified enough to permit using them as variables on which to base further calculations, their values are sterile at best.

Thus, the term "empirical" is here used as describing not only a means of dealing with observed results for which more rigorous scientific relations are lacking but also as a means of simplifying within a desired range of values, results which by a more exact expression are too complicated for normal engineering use.

Such results, to almost any desired accuracy, can be employed in the form of tables, curves, nomographs, or special computers. But, although no universal rule can be set, it is believed that equations in most cases have advantages of compactness, facility of visualization and checking, definite numerical significance, and adaptability to further operations not so well combined in any other form. And they can nearly all be handled by that one essential engineering tool, the slide rule. Believed to be next in order of utility are simple graphical constructions.

Any prejudice against the use of empirical methods is soon overcome when it is realized that, broadly speaking, nearly all modern science is essentially empirical in nature. A good example is the law of gravitation. Copernicus assumed the general nature of motion taken by the planets in their orbits around the sun. The earth could alternatively have been taken as the fixed center, but it was simpler the other way. Tycho Brahe followed with precise observations of the actual relative motions. Kepler, fitting Tycho's observations to the Copernican assumptions, plotted these orbits in more detail, fitted empirical curves to them, and found they all could be closely represented by ellipses with varying coefficients for the path and speed of travel.

Newton, attempting to coordinate the behavior of the planets with that of terrestrial objects, found that these coefficients could be evaluated by the simple assumption that the force between a planet and sun varies directly as the product of the masses and inversely as the square of the distance between them. Although even Einstein's later and still broader generalization can be considered empirical in the sense that it was chosen to fit observed facts and rational assumptions, it brings out more definitely the essentially empirical nature of Newton's law and its virtual necessity in dealing with the great mass of calculations for which, with few exceptions, it is perfectly valid.

The human side of the engineer's job is a tough one, too.

Getting Formula-Curvalues

To a practical engineer, mathematics is technical shorthand, in accordance with which a simple equation or formula may well be regarded as its supreme achievement. A good formula, by presenting a known group of facts, sets up a problem, shows a picture, points the way, and indicates the solution. Yet, followed blindly out of its proper domain, misunderstood, or otherwise misused, it well merits the disrepute into which it may fall. True, there is such a thing as being a slave to formulas; but he who understands them, sees the pictures that they point out their handwriting on the wall, is not their slave but their master. And the more he can get to serve him the better.

So, quite opposite to the one-time boast of "flight without formulas," let us have more and better formulas (although preferably not bigger ones!). These should be in explicit algebraic form where possible, but trigonometric, logarithmic, and other readily usable functions, are of course acceptable. Decimal exponents are usually simpler than trying to avoid them, and are no trouble on a log-log rule. Derivatives and integrals, if used, should be based on simple explicit equations, and integrations of any great difficulty should be confined to graphical solutions.

All this, of course, applies to routine engineering operations, not to exploratory or research activities usually calling for a specialist outside the regular engineering staff. *But such research should not be considered complete till its results can be put to use in practical engineering form.*

The means employed to accomplish this purpose will vary widely for different conditions, as illustrated by the following:

1. A few simple fundamental relations can be left unchanged. Elementary examples: Area of a circle; accelerating force.

2. Often a binomial occurs in the form $y = (1+x)^n$ where x is a small fraction, in which case $y \approx 1 + nx$. Example: Solution of the quadratic $ax^2 + bx + c = 0$,

$$x = \frac{1}{2a}\left(-b \pm \sqrt{b^2 - 4ac}\right) \approx \frac{b}{2a}\left(-1 \pm 1 \mp \frac{2ac}{b^2}\right) \text{ for } 4ac/b^2 = \text{small.}$$

3. A multiplicity of different variables can almost always be combined to form a smaller number. Example: $ax^2 + bx = C$ which can be put into the form

$$\left(\frac{a}{b}\right)^{3/2} x^3 + \left(\frac{a}{b}\right)^{1/2} x = \frac{a^{1/2}}{b^{3/2}} C$$

or $x^3 + x_1 = C_1$.

4. An implicit function, such as x, above, can be made explicit by plotting (or tabulating) the curve and fitting an

empirical equation to the portion covering the usable range A family of curves with more variables can be similarly treated (Even when a direct soultion is possible, such as for the above cubic equation, the result is usually too complicated for practical use) Example Solution of the basic performance equation for speed

5 A gradual curve of theoretical or experimental points can be approximated by a straight secant line cutting across two points of the curve, in a position to average the error within the desired useful range This method is generally superior to the more commonly used tangent line, exact only at one point and usually throwing the error all in one direction Example Approximation of maximum speed when induced drag is relatively small

6 More extended or sharply curved functions can be similarly approximated by a parabolic or other simple curve Example Variable profile parasite drag as a parabolic function of lift coefficient

7 A function in several terms, each in the form $Kv^m y^n z^p \ldots$, where K, m, n, p, etc, all have differing values in the various terms, can be approximated in fewer terms of the same form for any desired limited range of values. Example Wing weight as a summation of terms for surface, beam flanges, webs, ribs, etc.

8 Various methods of interpolation and extrapolation can be employed Although extrapolation is usually looked upon with disfavor, it can often be used to a moderate extent, provided there is no change of condition within the desired range. Example. Taylor's series is essentially a means of extrapolation from the characteristics at a single point, valid within the circle of convergence

9 Trial and error, guided by experience in the recognition and fitting of special curves, is invaluable for cases where a fairly complete range of values must be covered Example Variation of beam flange weight with taper characteristics

Although much remains to be done in thus putting into practical form the results of previous research, it is felt that a good start has been made In this and succeeding articles the symbols will be listed, the formulas classified, and references given, where available, for the basic theory as well as for equations recommended Many of the latter are presented for the first time The order of accuracy will be given within specified limits of the dependent variables. "Accurate" here has its usual engineering meaning—i.e., "Within slide-rule accuracy" Explanation of the more important formulas and examples of their use will be found in the text

To avoid transposition, all formulas are expressed directly in the customary units of lb, slugs, hp, deg F, air pressures in lb/sq ft, stresses in lb/sq in, distance in mi, altitude in ft, general dimensions in ft., moments in lb-ft., angles in deg, horizontal speed in mph, climb in fpm, and rotational speed in rpm. It is too bad we have never gotten into step with most of the world by adopting the metric system, but as long as we haven't, our own standards are followed all the way, the only liberties taken being that a few of the symbols, like altitude and engine speed, are in thousands of units to permit dealing with smaller numbers

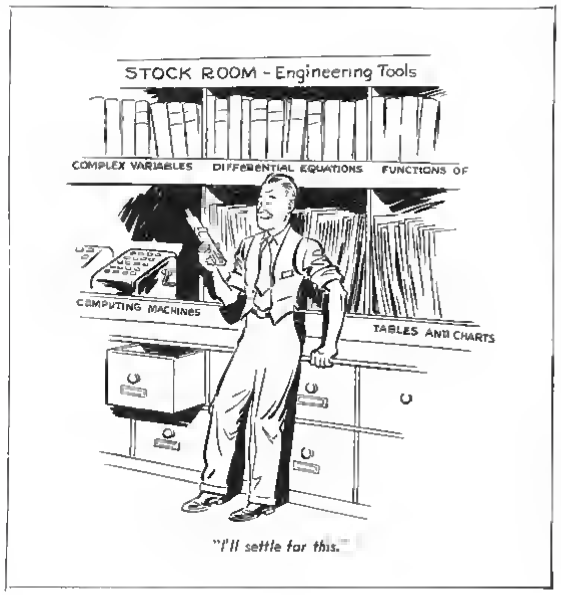
As there is room in this article for only a few elementary formulas, what better start can be made than with equations for the atmosphere itself, on which all aircraft design depends?

Except in the special cases noted, these formulas cover the entire troposphere (up to about 35,000 ft.), although it is hardly conceivable that the personal flyer would be interested in more than about 12,000 ft, unless for something like crossing the Andes. As will be brought out later in our series, however, it is believed that private pilots often miss good chances for improving their speed, fuel economy, and personal comfort by staying at too-low altitudes.

The aeronautical standard atmosphere is of course itself an empirical approximation, based on a somewhat arbitrary sea level pressure and the assumption of a constant temperature gradient or lapse rate in the troposphere[1] It starts with a sea level temperature of 59 deg F which is different, incidentally, from the physical standard of 0 deg C

Although the design engineer deals ordinarily with the standard atmosphere alone, the product of his work must be tested in an actual atmosphere where density, pressure, and temperature no longer have the unique relationship to each other and to the actual altitude assumed in the standard atmosphere. A properly adjusted altimeter gives the "pressure altitude" H_p, the altitude in the standard atmosphere corresponding to the static pressure

But, with the exception of engine power, the designer of low-speed aircraft is more directly interested in air density, hence the analogous term "density altitude" H_σ For the higher speeds a good case can be made for a "temperature altitude" What it amounts to is



[1] See comparison with typical average conditions in Ref 1

that all three characteristics must be considered in relation to different effects.

The relations between σ, p/p_0, and H in the standard atmosphere as given by Equations 1 and 2 can, of course, be taken alternatively from a table or chart. Still easier for the engineer is to think and deal primarily in terms of the relative density σ, which can be used directly in most computations Choice of a standard cruising altitude, such as for $\sigma = .811$ (7,000 ft), then permits, for most purposes, reduction of the "table" to values for sea level and this one other altitude, with formulas for *MN*, *RN*, power factors, and other related functions appearing on the same sheet, all in a form for quick use, with fractional powers of σ worked out in advance

For the usual moderate altitudes, Equation 3 gives a close approximation especially convenient for a pilot All he does is divide the density altitude in thousands of feet by 0.6 and add it as a percentage to the calibrated airspeed reading to get the true airspeed

Incidentally, the present accepted usage of "indicated airspeed" makes it something of a misnomer. As the very name implies, it originally meant the speed indicated by the instrument, but now it is customarily defined solely and specifically by the analytical expression here given However, an airspeed indicator adjusted, positioned, or calibrated to give all speeds correctly for $\sigma = 1.0$ will continue to give $v\sqrt{\sigma}$ within 1% for all atmospheric variations up to 20,000 ft "temperature altitude," and 200 mph indicated speed (Ref 3)

The Reynolds and Mach numbers, Equations 4 and 5, are from well known elementary theory, yet in most sources of information on these relations there is apparently no attempt to present them in really convenient form. No more accurate form for *RN* is needed than the one Equation 4. It may possibly be questioned why Mach numbers are introduced at all in a discussion of personal plane design The answer to this one must come later, in connection with propellers and some of the recent wing developments

In similar manner to the indicated speed, the reference pressure q, Equation 10, is simply a matter of arbitrary definition—for use as a convenient common factor in the various aerodynamic coefficients. Otherwise the equations here listed for the actual atmosphere will seldom be of real importance in lightplane design, but they are included for reference in simple form

So there you are –A barefaced espousal of intellectual economy! At any moment we may expect to hear the chorus of protest Indeed it has already begun It began at least as far back as Newton's analytical methods The words are lost, but the argument can be readily imagined "Formulas and short cuts! That's no respectable way to solve problems We should get back to Pythagorus and Euclid" And somewhat more recently "Who wants to be a handbook engineer?" Well I, for one, do—if by such means we can progress still further, accomplish a little more, and make room for more of the true fundamental sound, resourceful thinking in the approach to the many *new* problems still ahead in aircraft development.

In his next article, Mr Upson will discuss the all-important subject of performance

THIS MONTH'S FORMULAS

Standard Atmosphere

(1) $\sigma = (1 - H/145.4)^{4.35} = (p/p_0)^{.81}$ Ref 1

(2) $H = 145.4\,(1 - \sigma^{.235}) = 7$ for $\sigma = .811$ (7,000 ft)
(1) and (2) accurate for $H < 35$ and $\sigma > 0.31$ } 35,000 ft

(3) $v/v_i = 1/\sqrt{\sigma} = 1 + H/60$ Ref 2
within 1% for $H < 15$

(4) $RN = 9350\,c\,v\,\sigma^{.81} = 7,900\,c\,v$ for $\sigma = .811$ (7,000 ft)
Based on Ref 1
within 0 3% for $\sigma > 0.31$

(5) $MN = \dfrac{v}{762\,\sigma^{.215}} = v/745$ for $\sigma = .811$ (7,000 ft.)

Accurate for $\sigma > 0.31$

Actual Atmosphere

(6) $p/p_0 = (1 - H_p/145.4)^{5.26}$ Ref 1

(7) $H_p = 145.4\,[1 - (p/p_0)^{.19}]$ Ref 1

(8) $H_\sigma = 145.4 - (1.35/T^{1.235})\,(145.4 - H_p)^{1.235}$

(9) $\sigma = (519/T)\,(1 - H_p/145.4)^{4.26}$
(6), (7), (8) and (9) accurate for $H_p < 35$ and $\sigma > 0.31$

(10) $q = \sigma\,v^2/391 = v_i^2/391$
accurate by definition, for all conditions

(11) $MN = \dfrac{v}{33.5\sqrt{T}}$ Ref. 1
accurate for all conditions

(12) $p_s - p = q\,(1 + .26\,M N^2)$ Based on Ref 1
within 1% for $MN < 0.9$

Symbols

σ	$= \rho/\rho_0$ = air density relative to standard at sea level
	$\rho_0 = .00238$ slugs/ft^3
T	= absolute air temperature = 460 + deg F
p	= static pressure
p_0	= static pressure at sea level in standard atmosphere
	= 2,116 lb/ft^2
p_s	= pitot pressure, $p_s - p$ = measured dynamic pressure
q	= dynamic pressure for low Mach number (lb/ft^2) defined by Eq 8
v	= true airspeed (mph)
v_i	= indicated airspeed = $19.8\,\sqrt{q} = v\,\sqrt{\sigma}$
H	= altitude above sea level (thousands of ft)
H_p	= same, according to Eq 7 (pressure altitude—fictitious)
H_σ	= same, according to Eq 8 (density altitude—fictitious)
Note:	In standard atmosphere $H_p = H_\sigma = H$
c	= wing chord (ft) (or other designated dimension parallel to airflow)
RN	= Reynolds number, Eq. 4
MN	= Mach number Eq 5 and 11

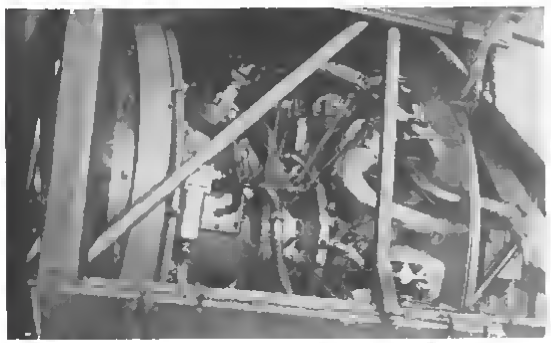
References

1 Richard von Mises, *Theory of Flight*, McGraw-Hill Book Co, New York City, 1945.
2. Walter Diehl, *Engineering Aerodynamics*, Ronald Press, New York City, 1936
3 Wm C Schoelfield, *A Simple Method of Applying the Compressibility Correction*, Journal of the Aeronautical Sciences, Oct. 1942

Seen here is development model of Flettner Fl-282 helicopter (minus rotors) now being tested in this country. Engine compartment is accessible via hinged side panels. Tail surfaces of this craft appear to have different characteristics from those of Fl 282B (see opposite page)

Design and Flight Characteristics Of the Flettner Fl-282 Helicopter

Presented here is a clear analysis of Germany's foremost rotorcraft development—the Flettner Fl-282. And included in this first, well-rounded study is sufficient detail to enable comparison of its engineering with that of our own 'copter types.



Close-up of engine installation with access panel lifted. Housing for fan is seen at left, while mounted at angle on top of crankcase is lower transmission

MOST ADVANCED of German rotary wing projects, and a craft which has flown more hours than any other Nazi 'copter, the Flettner Fl-282 Kolibri has aroused great interest both here and abroad, despite the fact that little detailed information has been heretofore available.

Extremely maneuverable, according to a U S TIIC report by Bertram Kelley and Hugh J Mulvey, this two-place craft with intermeshing two-bladed twin-rotors and substantial tail surfaces has been flown in very bad weather, rain, and gusty air, also has been piloted blind Many tests were conducted—for autorotation, altitude, speed, stability, vibration, and vibratory stresses—and hundreds of power-off landings were made. In an endurance test, one ship was flown 95 hr without repairs or changes Permissible C G travel allows flight with and without passenger without changing trim, although this procedure increases vibration

At 2,200 lb. gross weight, vertical climb at sea level is given as 300 fpm Maximum speed in level flight is 90 mph., and hovering ceiling is roughly estimated to be 1,000 ft. With disk loading of 1.8 lb./sq ft., the vertical autorotative descent is given as 26 ft./sec, although apparently no systematic tests were made at very low speeds to show rate of descent as a function of speed. Maximum speed of sidewise flight is about 15 mph., and maximum diving speed is about 100 mph

Stability

The craft is stated to be neutrally stable in hovering If the stick is given an arbitrary displacement, and then held fixed in central position, the craft will execute a swinging motion, amplitude of which neither increases nor decreases. In forward flight, there is a longitudinal instability, reaching a maximum at about 25 mph, and at speeds greater than 37 mph flight is again stable Period of phugoid instability is about 11 sec when stick is held fixed In forward flight above 37 mph, the craft can be flown hands-off for an indefinite period by adjusting a bungee in the cockpit to neutralize stick load

An interesting feature of the phugoid oscillation is that if the stick is suddenly displaced forward, then returned, motion is stable, whereas if the disturbance is caused by a sudden rearward displacement, motion is unstable.

The craft is stable in yaw Approximately two oscillations per minute have been observed, but amplitude does not increase.

Vibration

The Flettner 'copter is considered rough The two bladed rotors (synchronized to be parallel in the 45 deg positions) produce fuselage vibrations which appear to be torsional about the vertical axis Blades are provided with flapping and drag hinges, the latter damped by adjustable metal to-metal friction There are no other means of isolating aerodynamic forces from pilot During revup, the craft shakes rather badly on its landing gear (the vibration being sensitive to tire pressure) but sweetens up before takeoff In flight, control stick vibrations were at first severe, but were greatly reduced by the well known means of adding inertia to the system Movement of either cyclic pitch pushrod drives a sector, engaging a worm to which a small flywheel is attached Although this device substantially cured control stick vibration, it involves disadvantages of having a sluggish stick and tendency to overshoot a given displacement Mr Flettner has emphasized that when the drag hinge friction dampers are very carefully adjusted, vibrations of the craft are much reduced (Recommended setting is slippage at 94 lb ft. applied torque.)

Dr Kurt Hohenemser (theoretical expert from Göttingen, who performed extensive calculations of stability, vibrations, and performance) has shown by analysis that a self-excited oscillation could occur in flight at low rpm and

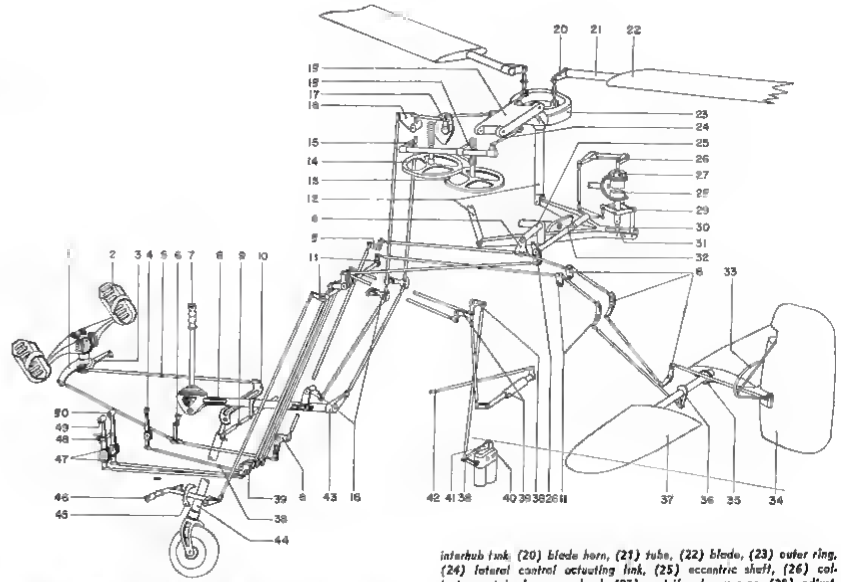


Diagram of Fl-282B controls; (1) Steering lever, (2) steering pedal, (3) friction damper (4) fuel cock lever, (5) nose wheel steering pushrod, (6) rudder bellcrank, (7) stick (8) control shaft, (9) lateral control neutral point, (10) nose wheel steering lever, (11) elevator trim bellcranks, (12) directional control actuating rod, (13) lateral control inertia ring (14) longitudinal control inertia ring, (15) lateral control link, (16) longitudinal control linkage, (17) sector engaging worm, (18) lateral control segment and worm, (19) lateral control interhub link (20) blade horn, (21) tube, (22) blade, (23) outer ring, (24) lateral control actuating link, (25) eccentric shaft, (26) collective pitch change pushrod (27) centrifugal governor, (28) adjustment release, (29) governor feedback, (30) release lever, (31) yoke lever (32) lateral control yoke, (33) C. G trim, (34) rudder, (35) friction damper, (36) elevator bellcrank, (37) elevator, (38) fuel cock pushrod, (39) throttle bellcranks (40) fuel filter, (41) hand-pump lever, (42) quick-acting carburetor cutoff lever, (43) lateral control crank, (44) nose wheel strut, (45) elevator trim lever ratchet sector, (46) elevator trim lever (47) adjustable dampers, (48) setting mechanism (49) collective pitch lever, and (50) throttle lever.

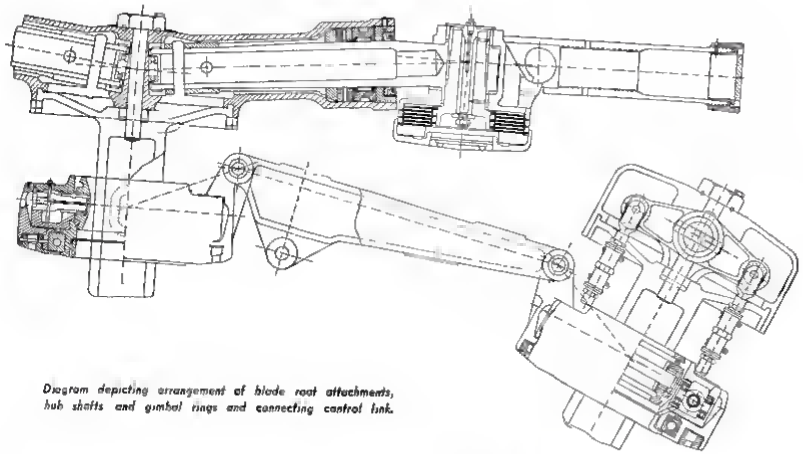


Diagram depicting arrangement of blade root attachments, hub shafts and gimbal rings and connecting control link.

high pitch This oscillation was experienced severely on one occasion at 140 rotor rpm, but disappeared when the craft was put into autorotation and rpm increased

Vibratory stresses at critical points were measured by strain gage technique and were found to be excessive in the control links at maximum speed As a result, diving at high speed was prohibited

Detail Design

Rotor blades These are of conventional construction, embodying 1.5-in. o.d. .138-in. steel tubular spar, wood ribs attached to steel collars, plywood cover, and fabric over the plywood. Blades are straight, have 19.65-ft. radius, and 11.42-in. chord The .039-in. plywood cover is wrapped over the leading edge, which is 63 in. wide Trailing edge is laminated vertically and has total width of 1.34 in. from ribs 1 to 16, and .98 in. outboard of rib 16 Rib components have built-up construction of two capstrips with plywood webs on either side, and are uniformly spaced at 3.9 in. along entire blade A solid block is added between capstrips at the spar for riveting rib collars

Blade has twist of 4 deg., the angle of incidence decreasing from inboard to tip Turned-up tab, 17 in. long and extending .79 in. to rear of trailing edge, is installed just inboard of the tip The tab is fixed but can presumably be bent to change blade moment coefficient

Blade section appears to be of NACA 23000 series with 17% max. thickness

Originally, blades were built with chordwise balance weights only on outer half This was found to be unsatisfactory, hence similar weights were added on the blade inner half Weights are attached to leading edge aft side with screws. Total weight of the blade is 88 lb.

Lacquer is used on the fabric cover to obtain a very smooth uniform surface, and thus maintain blade balance Protracted flights are claimed possible in rain or snow, without damage to leading edge

Spar is threaded on inboard end for attachment to a sleeve having a forked end forming part of the horizontal hinge. The sleeve telescopes over the spar for approximately 6.3 in., so that the spar threaded section is some distance from point of maximum moment on the spar. A pin through sleeve and spar prevents relative rotation.

Rotor hub and transmission The twin two-bladed rotors are mounted on shafts having an included angle of 24 deg. and spaced 23.2 in. apart at the intersection of the planes of the horizontal pins and centerlines of rotation. Horizontal and vertical blade-hinges are coincident and located at 12.8 in. outboard of centerline of rotation. Location of the horizontal hinges so far outboard permits hubs to be brought closer together, gives better blade clearance, and affords added advantage of producing greater control moment for given flapping Disadvantage is greater roughness with divergence of tip path plane from the plane normal to mechanical axis. This divergence varies with forward speed and C.G. position Hence, it is possible to have considerable roughness in hovering if C.G. is such that tip path plane is not perpendicular to axis.

Bearings for pitch axis of blade are located inboard of horizontal and vertical hinges, and the axis is inclined up at an angle of 6 deg. to centerline of rotation Since the control is located inboard of hinges, it is not affected by movement of blade about hinges Vertical hinge is parallel to centerline of rotation, hence is 6 deg. from normal to pitch axis.

Vertical and horizontal hinges, as well as pitch change axis, have needle bearings. Thrust bearing for pitch change axis is also a needle bearing. Load on the bearings of the hinges is about 5,000 psi., based on nominal projected bearing area No trouble was experienced with these bearings under this loading

Blade dampers mounted on the vertical hinge are friction type with multiple steel and brass plates. Load is applied through a rubber disk, pressure being adjusted by turning the damper cap Usual setting of damper gives a torque of 94 lb.-ft.

Centrifugally operated droop stops installed on blades allow rev-up at a coning angle of plus 1 deg. and still permit the blades to flap down to an angle of minus 5 deg. in flight The stop is a cam moved by a hinged weight, which flies out because of centrifugal force. At 110-120 rpm., the cam moves and allows the blade to fall to an angle of minus 5 deg. To set the slop for a coning angle of plus 1 deg., the blade must be raised by hand until a spring moves the cam into proper position—this being automatically accomplished if the collective pitch setting is sufficiently large as the rotor slows down.

Upper transmission, providing the mounting for the two hub shafts, is supported on a steel tubular structure, similar to an engine mount, attached to the fuselage at upper longerons

The two hub shafts, mounted in roller bearings, with an additional ball bearing to take thrust, are geared to a short cross-shaft upon which is mounted another gear meshing with a central pinion shaft. Design of the cross-shaft is somewhat unusual and, while heavy, the unit should give very rigid mounting for the pinion on either end To decrease the diameter of the bearings for mounting this shaft, the latter is used as the inner race.

On the central pinion shaft is mounted the freewheeling unit, which disconnects the engine and upper transmission. A rotor brake installation is also mounted on the shaft

Upper and lower transmission units are connected through a short drive shaft having a universal joint at each end Lower transmission is mounted on forward end of engine crankcase, and pinion of this unit is mounted on the crankshaft, using usual propeller splines and cones. This transmission changes the direction of drive (upward and aft 65 deg.) to line up with upper transmission On the nearly vertical shaft is mounted a multiple disk clutch and a dog-type coupling To rev up rotor, friction clutch is engaged by moving a lever in cockpit. When engine and rotor tachometers indicate that there is no slippage of the clutch, the dog type coupling is engaged by further movement of clutch lever. Because propeller shaft was not long enough, an extension was added to allow for mounting the fan forward of the transmission

With three sets of gears, the two transmission units effect a total reduction of 12.2 to 1 between engine and rotors When the engine turns at 2,200 rpm., rotor turns at 180. All gears are spiral bevel. Considerable use of roller bearings is made, ball bearings being used only where thrust or combined thrust-and-radial loads require them Since transmission cases are made of magnesium, heavy steel sleeves are inserted wherever bearings are located.

Controls Joint cyclic pitch change of the two rotors (tilting both gimbal rings in the same direction) accomplishes longitudinal and lateral control.

Steering control is obtained by a combination of rudder and differential collective pitch change on the two rotors. The large rudder is necessary to give sufficient directional control during autorotation, since the differential collective pitch is ineffective in this condition It is claimed that in power operation, sufficient control in yaw is available to accomplish all maneuvers, even when hovering in winds of 20 mph. Some trouble has been experienced by new pilots when operating very low, because as they come around into the wind they lose lift and strike the ground

Adjustable stabilizer is provided, but a setting of plus 4 deg. has been found to be satisfactory for all forward speeds.

Collective pitch control is located adjacent to throttle so that both may be moved simultaneously, if desired. This pitch lever does not actuate the collective pitch directly but operates it through a blade-pitch governor.

Blade-pitch governor holds rotor rpm within certain limits Mechanism controlling pitch consists of springs acting against levers moved by centrifugal force, the springs tending to decrease pitch and the levers tending to increase it. Initial spring load can be adjusted on the ground to govern at any desired rpm., also minimum angle can be set, below which the governor cannot further reduce pitch. This latter setting is chosen to give positive autorotational characteristics in event of power failure.

In early tests of the craft, the governor was set for a minimum of 140 rpm., and in one instance of power off flight, autorotation actually stopped, the craft dropping to hit the ground very hard On another occasion, self-excited vibrations were encountered in flight. After these episodes, the governor was set for a minimum of 160 rpm

Collective pitch lever allows pilot to override the governor and adjust pitch It has been stated that pilot can override governor only to increase rpm., but cannot reduce the rpm below that of the governor setting

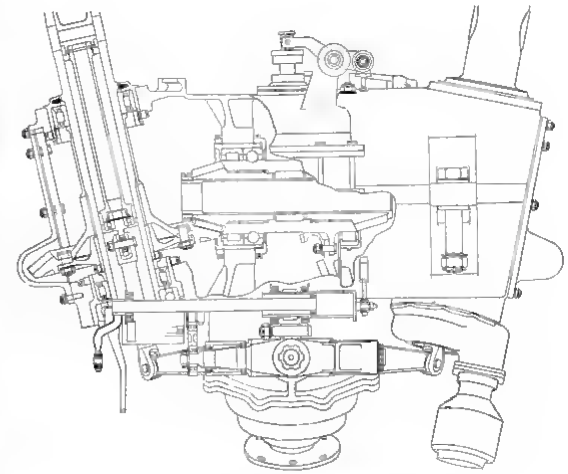
Governor is power-operated through two oppositely rotating clutches driven from upper transmission.

Specific values of pitch angles used in the controls, are:

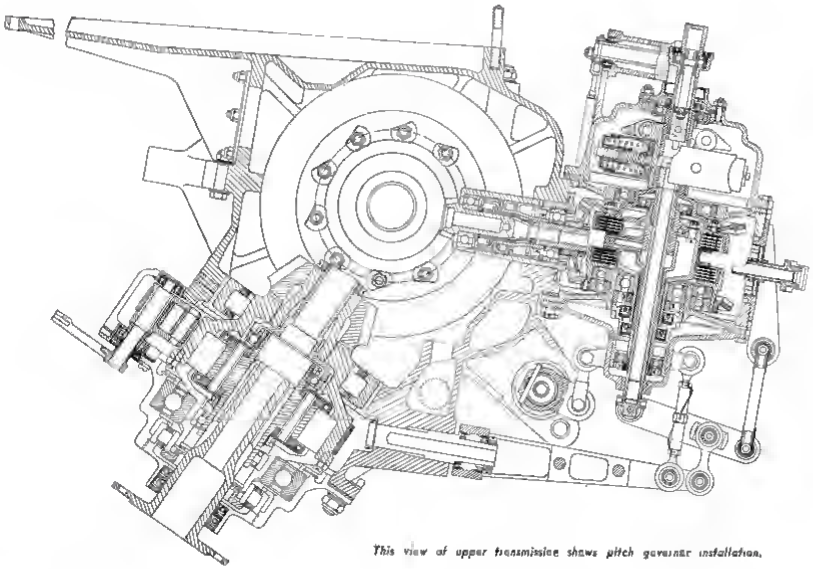
Maximum collective pitch	8 deg.
Collective pitch required for hovering	6.5 deg.
Cyclic pitch, forward feathering	8 deg.
aft feathering	4 deg.
lateral feathering	3.5 deg.

Engine installation Power plant is Siemens Halske 7-cyl. radial, aircooled installation mounted with crankshaft horizontal Rating is 140 hp. at 2,200 rpm. for sea level takeoff, and cruising rpm. is 2,050. Engine overhaul period is reported as 400 hr.

An eight-bladed 26.8-in. dia. wooden fan is mounted on an extension to the propeller shaft. Air enters at fuselage bottom, passes through fan to engine,



Details of upper transmission connecting two hubs and of collective pitch linkage to hubs.



This view of upper transmission shows pitch governor installation.

and down and out through another opening in fuselage bottom No means of controlling air flow is provided. Normal engine temperature is 225 deg C. (437 deg F).

Fuel capacity is 105 l (27 8 gal) in two tanks, but with two people, fuel load is limited to 65 l (17 2 gal.)

An oil sump, located under engine nose section, holds approximately 2 gal of oil, and also serves as a tank. A filter cleans the oil every 2 hr. Oil consumption is approximately 1 qt./hr

Two carburetors are used, opening into the same manifold No mixture control or means for preheating air is provided.

The engine is started by utilizing a high pressure air tank connected to the cylinders through a distributor, and with ignition "on," fuel is pumped into the intake manifold Air pressure of 200 psi is sufficient for warm weather and 400 for cold.

Conventional steel tubular engine mount is bolted directly to intake manifold, with no vibration absorber

Landing gear Gear is of the trieyale type, with spring oil shock struts. On the main gear, the shock strut is inclined inward at an angle of 35-40 deg. from vertical and is subject to bending because of wheel offset Total strut travel is 2.36 m and the vertical wheel travel is 4.33 m. Tires are 18.32 by 6 50. Tread is 81.5 m with shock strut extended and 64.3 m compressed. Nose wheel strut travel is 6.30 m and vertical wheel travel is 4.92 m. Tire is 13 80 by 5.12 Nose wheel is steerable, being connected to rudder pedals

The craft has been landed from vertical descents in the manner characteristic of autogiros (by pulling back on control stick after nosing down from vertical descent), collective pitch not being used. In one such landing the tail was damaged by hitting the ground Dr Hohenemser recommends that a ground angle of approximately 20 deg between wheels and tail is desirable for this type of landing

Body Fuselage construction features welded steel tubes Center section enclosing engine is metal-covered and rear section is fabric-covered. Body shape is not aerodynamically desirable, since tuft tests have indicated that flow separation (or turbulence) is so great that it makes much of the tail surface ineffective.

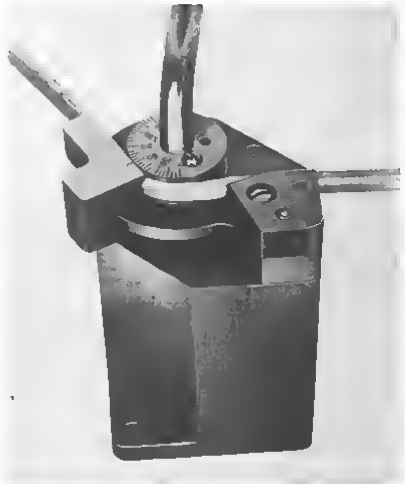
Although only 22 craft were actually constructed, plans were under way for production of 1,000 units as the European war ended General quality of design and workmanship is excellent, although drive mechanisms, pitch-actuating governor, and controls are, in many instances, unnecessarily heavy and complicated. The combination of 140 hp, 1,400 lb. empty weight, and 2,200 lb gross weight (with good performance), indicates what can be accomplished with this configuration, using a 39 3-ft. dia rotor. Compared with the tail-rotor type craft, it has been found that only slightly less hp and engine weight are required, but a greater weight of rotors and drives, droop stop mechanisms, controls, and other installations are necessary

General Data

Empty weight	1,410 lb
Gross weight	2,205 lb
Rotor diameter (each)	39 3 ft.
Engine	
7 cyl, radial aircooled Siemens Halske	
Engine takeoff rating, S. L.	140 metric hp.
Fuel, one person	27.8 gal
Fuel, two persons	17.2 gal

Rotor Characteristics

Total incl angle between axis	24 deg
Blades per rotor	2
Blade chord	21 42 in
Disk area	1,212 sq. ft.
Disk loading at 2,205 lb	1 82 lb./sq. ft.
Solidity	.05
Forward feathering	8 deg
Lateral feathering	3 6 deg
Aft feathering	4 deg
Rotor turns, best cruising	175 rpm
Rotor turns, takeoff	
180 rpm (engine, 3,300 rpm.)	



Manual Bending Tool Gives Improved Accuracy

■ Designed to enable bench workers to bend tubing with greater accuracy than had formerly been possible, this simple device may also be used for working heavy electrical cable, such as is installed for battery leads

Tool consists of a heavy base, fitted with a graduated center, around which material is bent. At right is a stationary block, so placed that stock to be bent is tangential to center piece at the zero-degree mark Pivoted on lower part of center is movable block (left) which is rotated around center piece until required bend has been obtained in tubing On top surface of movable block, a mark is placed to indicate point of tangency of tubing being worked upon

Designed by Carroll E Andreen, employee of Glenn L. Martin Baltimore plant, tool has these three advantages over old bending methods: Greater accuracy than that usually specified can be obtained, time formerly lost in measuring angle of bend is saved, and material is no longer wasted through being flattened or split during bending operation

Time and Labor Saved by Gusset Clamps

■ This tool, made from two U-shaped steel plates, is adjustably bolted together and fitted with a locating arm for holding it at right angles to work

Used for positioning and holding nose rib gussets at Glenn L. Martin plant, this device is stated to have reduced working time from 14 min to less than 3. Further, it enables one man to complete work which formerly required labor of two.

Because hand layout is no longer needed, accuracy of finished work is considerably higher than before this tool was introduced by John Haines, inspector in PBM Mariner shops.

Design Details of

Metro-Vickers F/3 Turbojet

Ducted fan thrust augmentation is feature of new British unit which has 2-stage turbine compressor and two 2-stage contra-rotating turbines to drive fans.

By JOHN FOSTER, Jr., *Managing Editor, "Aviation"*

THRUST AUGMENTATION through use of contra-rotating fans is among the latest British turbojet developments.

Just revealed, the new unit, developed from the Metropolitan Vickers F/2, is designated F/3 and develops, from the straight hot jet, 2,400 lb static sea level thrust for a weight of 1,650 lb and, with the fan augmentation, a thrust of 4,000 lb for a weight of 2,200 lb. This gain in thrust is accomplished without any fuel consumption increase, the result being that the engine has a specific fuel consumption of 0.65 lb./hr./lb. thrust.

Basically the airflow is simple. Through a 9-stage axial flow compressor, into an annular combustion chamber, through a 2-stage turbine driving the compressor, through two 2-stage contra-rotating turbines driving the fans, then on out separate exhausts, the two streams joining at the jet pipe end.

Unlike most axial flow compressor casings, conventionally symmetrical in shape, the casing on the F/3 has a larger diameter at the intake than at the turbine end. It is built in four sections, which bolt together along axial flanges, with a circumferential flange at the sixth compressor stage. Stator blades—70 to a row—are peened into dovetail-section slots machined into the casing.

The starter motor and oil pumps are housed in a spinner-type fairing at the intake end, with the air entering the annulus between four concentric rings attached to faired spokes to form a grid. Other accessories are mounted atop the compressor casing, the drive being from a vertical shaft set just ahead of the front thrust bearing.

Drum of the compressor is a single piece forging with machined serrated slots in the outer surface taking the turbine blade roots, which are spaced by distance pieces and peened in place. There are 65 blades in each compression stage, all similar in design.

Bolted to a flange inside the compressor drum at the third stage is a conical diaphragm, the apex of which is attached to the front thrust bearing and which is splined to transmit power through a quill shaft to the accessories.

Also bolted to a flange at the downstream end of the compressor drum is another, but more elongated, cone which extends aft inside the annular combustion chamber, ending in an internally-splined sleeve that runs in the turbine bearing and houses the turbine shaft.

At the upstream end of the combustion chamber, a deflector ring divides the air into two annular streams, directing most of it around the flame tube, which is housed concentrically within the chamber. Both inner and outer walls of the chamber contain 30 wedge shaped inlets which are set in two staggered rows of 20 inlets each to admit the air into the flame tube downstream from the burners. Just downstream from the deflector ring is a circumferential end plate pierced by rings of small holes to meter and set up turbulence in primary air from the compressor. The 20 burners are plain shrouded tubes set 18 deg apart with nozzles forcing fuel upstream at 650 psi.

The combusted gas moves through 5b turbine nozzle vanes, through the first stage of the compressor turbine—which has 80 blades, then through a ring of 84 stator blades and through the second 80 blade stage of the turbine compressor.

This compressor turbine has a single disk with a T-shaped rim supporting both rows of blades, which are anchored by bulb type roots locked in place by peening.

Immediately downstream from the turbine compressor are two contra rotating two stage turbines for driving the fans. Disks of both fan turbines are swept forward, this to allow room for bearings at the hub and to get the blades close to the compressor turbine. Each fan turbine is carried on a pair of roller and ball thrust bearings, both sets running on a common shaft supported by a six-point tubular brace, which also supports the fan ducting and jet cone.

First row of blades of the first fan turbine are set just forward of the disk, with the fan blades being mounted on a ringed shoulder extending out from the blade tips. The second row of turbine blades is mounted on the downstream edge of an extension of the disk rim. The downstream row of the second fan turbine's blades are set in the rim right over the disk, with the upstream row being supported from the outside by a crown extending forward from the second row blade tips, this shoulder also supporting the second row of fins.

Thus the four rows of fan turbine blades are nested, with one row of each being interposed between the rows of the other. Since the blades are contra rotating, the need for stator blades is eliminated. The first row of fan blades rotates at 2,850 rpm., the second at 2,300 when the compressor turbine is turning at its maximum of 7,600 rpm.

Air intake for the fans is an annulus, with inlet guide vanes located around the turbine compressor. Annulus overall diameter is 48 in. Air from the fans is exhausted through an annular tapered throat which surrounds the jet gas stream, but is separated from it by a double skinned wall which keeps the two air streams isolated until they meet at the jet orifice.

Cooling air—some of which is also used for lubrication—is taken from the fourth, sixth, and final compression stages and from the secondary air from the combustion chamber.

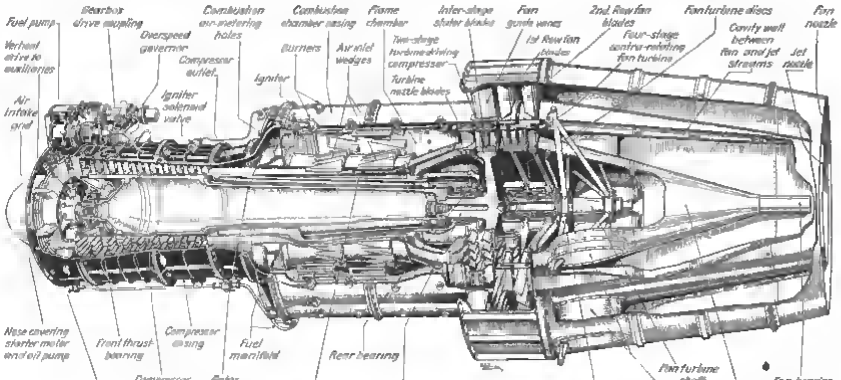
Radial holes drilled in the compressor rotor at the fourth stage take air inside the rotor, where it flows through the conical extension to energize an air-oil mixer to provide an oil spray for the turbine bearing. This spray is then evacuated through the cavity between outer and inner cone extensions, to be gathered in a circumferential duct around the outside of the compressor outlet, where it is vented to the atmosphere. External piping also supplies air for a similar air-oil mixer used to lubricate and cool the front bearing, the drain to the atmosphere being through a pipe inside bottom spoke of the air intake shroud.

Additional air is bled off at the sixth compressor stage and ducted through the tubular members of the six-point fan-support frame to the interior of the hollow turbine shaft. Part of this air supply goes through an air-oil mixer to lubricate and cool the fan turbine bearings, the remainder being used to cool the downstream face of the compressor turbine disk and the upstream face of the forward fan turbine disk. Spray from the fan turbine bearings is exhausted into the tail cone bullet, escaping into the jet stream at the jet orifice.

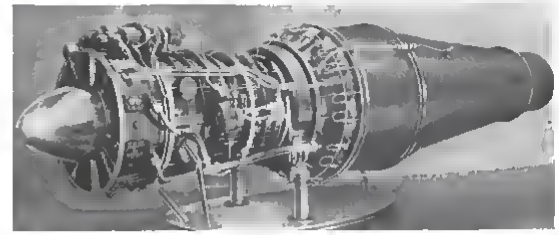
Air from the final compression stage is bled through a channel between outer and inner cone extension to the front face of the compressor turbine disk, where a deflector plate directs it toward the center of the disk, from where it flows radially outward into the jet stream past the blade roots.

Some of the supply of secondary air for the combustion chamber is bled off to cool turbine blade tips and both roots and tips of stator blades, and also to cool the fuel nozzles. This latter air is taken into the shroud near the root and exhausted through vent holes near the nozzles.

The F/3's fuel system is conventional, the fuel flowing from the tanks to a low pressure filter to the suction side of the engine driven pump, which sends it to the throttle valve. From here it is taken to a centrifugal governor and then to the main high pressure valve and the manifold. The now-usual barostat to regulate fuel flow according to altitude is used, being fed by a line from the pump. Another line, taken off just before the throttle valve, supplies a solenoid and two starting igniters set just off center at the top of the combustion chamber.



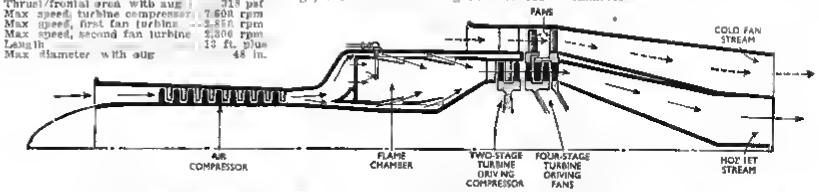
Cutaway drawing of Metropolitan-Vickers F/3 axial flow turbojet with ducted fan thrust augmentation—unit which gives specific fuel consumption of 0.65 lb./hr./lb. thrust. Shown are long conical compressor rotor extension, 2-stage turbine and arrangement of two contra-rotating 2-stage turbines driving fans. (Max Miller sketch re-drawn from "Flight.")



Metro-Vickers F/3 was developed from this F/2, which had 10-stage compressor and single-stage turbine. F/2 was first British axial flow unit to fly.

Specifications and Data

Thrust, max. SL, with augmentation	4,000 lb.
Thrust, max. SL, jet alone	2,400 lb.
Weight, with augmentation	2,200 lb.
Weight, jet alone	1,650 lb.
Specific fuel consumption (with aug.)	0.65 lb./hr./lb. thrust
Thrust/frontal area, jet alone	321.5 psf
Thrust/frontal area with aug.	318 psf
Max. speed, turbine compressor	7,600 rpm
Max. speed, first fan turbine	2,850 rpm
Max. speed, second fan turbine	2,300 rpm
Length	13 ft. plus
Max. diameter with aug.	48 in.



Cross section sketch from "Flight" depicts flow of air through 9-stage axial flow compressor, annular combustion chamber, 2-stage compressor turbine and two 2-stage contra-rotating fan turbines. Air streams from hot jet and fans are kept separate until they reach jet orifice.

Instrument Research Demands Unremitting Efforts

By **CHARLES H. COLVIN**, *Consulting Engineer*

This graphic account of the 22 painstaking and costly steps required in the successful development of an aircraft instrument—from initial suggestion to final factory production—clearly points up the prime attention which must be given to the evolution of these devices.

BASICALLY, THE WORD "RESEARCH" has two connotations. To the scientist it means experimentation to establish data and/or test theory; to the industrialist it has a broader meaning—coverage of all the processes whereby a device or material is conceived and carried to the point where it is ready for production. The former is called scientific or fundamental research, the latter applied or industrial research.

There is a general pattern in all aircraft instrument research and development. It begins with recognition of the problem, and it ends, insofar as the research and development department is concerned, with the test of the prototype and approval of the finally revised specifications and drawings.

Sometimes the existence of the specific problem is initially recognized by the potential user—in the case of aircraft instruments, the military or civil aircraft operator. And sometimes it's noted by the manufacturer, designer, or research worker. But in any event the real starting point of all research or development is the formulation of a clear statement of the problem. Dr. Elmer Sperry used to say that a problem well stated was half solved. Easy or hard, the complete written statement of the problem is of utmost importance. Many have been the man-hours wasted in work on inaccurately or incompletely stated problems.

For example, when work was started on what later became the Sperry Turn Indicator, the problem was stated as the indication of lateral level. The first instruments had a horizontal indicator bar which was to remain laterally level, under the combined influence of gravity, a spring, and the gyroscope. When it became apparent that the problem was really the indication of rate of turn, the pendulous control was eliminated, a vertical hand was substituted for the horizontal bar, and the solution became quite straightforward. Accordingly, only five years of development was required to put a satisfactory turn indicator into production.

Once a problem has been clearly stated, the nature of the device for solving it is frequently obvious. With some problems, half a dozen solutions may appear equally promising, while with others no answer will be immediately apparent. Sometimes, when the customer or the sales department proposes a device which is not even theoretically possible, research and development temporarily give way to tact and diplomacy.

When the general nature of the solution has been determined, a specification should be prepared, though in many respects it must be tentative. It is desirable to divide the specification into three sections: Structural, performance, and economic. Structural requirements should be kept to a minimum. In an aircraft instrument intended for panel mounting, however, they must include mounting dimensions, weight limit, dial illumination, and the voltage and the cycles on which the instrument is to operate.

Fig. 1. Before development of this design, the size, cost, and maximum calibration error had to be determined.

Operating characteristics and permissible limits of error will be covered under performance.

Structural limitations must not prejudice performance. There is, for example, a famous government specification in which the material, cross section, diameter, and number of turns of a hair-spring are set forth—and then the performance is specified in terms of torque vs. angular displacement.

Permissible unit cost is an anticipated quantity come under the economic section.

Rarely will it be possible to be definite on all points, but the more complete and precise the initial specification, the less the development cost is likely to be. For example, when Kollsman undertook the development of a sensitive air speed indicator (Fig. 1) it was determined in advance that the size should be that of a standard 3½ in. case 4 in. deep, that the maximum calibration error could be 2 mph., and that the price could not exceed $50.

Another reason for preparing the specification with great care is that, after approval by all concerned—normally, the customer, management, sales, engineering, and research groups—all are committed to it, and changes require the approval of four or five groups.

Up to this point, the project has been a cooperative effort of user, seller, and engineer or scientist, but from now on it becomes the responsibility of research and development.

First task is to determine whether the project may be solved by the application of known engineering principles or techniques, or if it will require fundamental research. Also management and the research director should want an estimate of the man-hours of research and engineering likely to be required.

Next is the preparation of a proposal to management. If research is indicated, it will be suggested that the required work be undertaken, to be reviewed for continuance or termination after *x* weeks or after the expenditure of *y* man-hours. If it appears to be a straightforward engineering job, it will be estimated that the work can be done in *x* weeks using *y* man-hours. Generally these estimates will be broken down into drafting, laboratory, experimental shop, and flight test time.

Now comes management's big decision—to risk or not to risk. A wrong decision made promptly may cost less than the right decision too long delayed. Frequently, approval must also be secured from the customer, and he also will do well to act quickly. If a project can be started while the preliminary study is still fresh, much time is saved.

Once approved, and with funds appropriated, the project returns to the research and development. A detailed study is made and the project is broken down into its essential components, each of which is allocated to an individual or group for study. It is not unusual for one or more phases to be entrusted to some outside agency.

An excellent example of such a component study is to be found in the development of the Kollsman electrically heated pitot static tube (Fig. 2). Basic divisions of the project were aerodynamic, structural, and thermal. The group studying aerodynamic problems called on the NACA and on the AAF for assistance. The structural group studied methods of fabrication, an electro-depositing process having been settled upon as most promising. The thermal studies were made in cooperation with the Goodrich Co., employing that company's icing wind tunnel.

The Pioneer Air Position Indicator provides another good example. This project was allocated among staff members, who thereupon studied the separate problems of air mileage measurement, adaptation of compass indications, and computing mechanism.

Completion of such studies should bring the project to the point where a preliminary layout can be started. If not, it is a good time to reappraise the whole undertaking, and to tell the management the bad news, either getting an extension of time or funds, or both—or agreeing that it is one of those unfortunate projects that had better be abandoned before any more time and money is spent.

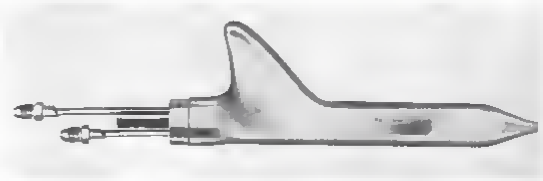


Fig. 2. To design this seemingly simple Kollsman electrically heated pitot static tube, project was divided into aerodynamic, thermal, and structural sections. NACA and AAF were also called upon for assistance, while experimental work was performed in Goodrich icing wind tunnel.

Assuming that the study and reassembly of the components has indicated a clear path to be followed, the preliminary design is then undertaken.

This leads to, or may be concurrent with, the construction of a "breadboard" model or a mockup, the tests of which will provide data for the design of the experimental unit.

Examples of such models can be drawn from everyone's experience. Either of the Fairchild versions of the A.P.I. might be cited. In the mechanical device, a rough sample gear set was built up with the necessary differentials, with a variable throw ratchet controlled by a cosine mechanism. In the electrical system the various elements were similarly strung out on a board.

For many instruments, a wooden or plaster mockup aids in the placement of control knobs and other elements, for best visibility or for greatest convenience.

Depending on the nature of the device, the model may or may not have a close relation to the final form of the apparatus. Here is found a wide difference of opinion as to the desirability of attempting to introduce production thinking. Some persons insist that the production engineer be brought in at this stage so that the ultimate design may be easier to build. Others feel that the men who do research, development, and experimental work are better left unhabited. To the production man anything new is suspect, while it is the job of the researcher to do new things or to do old things in new ways.

To quote from Professor Bichowsky's excellent book on industrial research: "The primary difference is in point of view. The research man, if he is worth anything, must be able to find the grain of gold in the pan of gravel; the production engineer must be able to see the fly in the ointment." Better results have been obtained by keeping the production engineers in the background at this stage of the project. A more important consideration is the possibility of building the experimental design quickly and easily with available facilities.

Next comes construction of the experimental unit which, if the company be well organized, will be in an experimental shop.

With completion of the experimental unit, which will probably be assembled

Necessary Steps in Pattern of Instrument Research And Development

	Operation	Responsibility*
1	Recognition of problem to be solved	C S or R
2	Formulation of statement of problem	C S or R
3	Proposal of general nature of device to solve problem	C S or R
4	Preparation of specifications for device	C S or R
5	Approval of specifications	C M S and R
6	Study to determine if only application of known engineering principles and techniques will be involved, or if research—that is, discovery of new principles or techniques—will be required	R
7	Proposal (a) if research: That work be undertaken to be reviewed for continuance or termination after *x* weeks or expenditure of *y* man-hours. (b) if engineering: That job can be done within *x* weeks using *y* man-hours	R
8	Approval of proposal and appropriation of funds	M (and C)
9	Detailed study and breakdown of project with allocation of component problems	R
10	Preliminary design	R
11	Construction and tests of "bread-board" models and mockups	R
12	Experimental design	R
13	Construction of experimental unit	R
14	Tests of experimental unit	R
15	Re-design of experimental unit	R
16	Construction of re-designed unit	R
17	Tests of re-designed unit	R
18	Design of prototype	E
19	Construction of prototype	F
20	Tests of prototype	R (and S or C)
21	Revision of specifications	C S and R
22	Approval of revised specifications	C M, S, R, E, and F

*Code: C customer, M management, S sales department, R research and development dept., E production engineering dept., and F factory.

in the laboratory, the comprehensive test program begins. Coincident with the design work, and based on the performance characteristics stipulated in the specification, the testing should have been planned so that it may follow a logical pattern. While the types of tests will be dependent on the nature of the device, in general they will be directed to a determination of the instrument's calibration, its accuracy and precision, its performance at high and low temperature, its power consumption, the effects of vibration on its indication, and on the wear of its parts, etc.

Testing may represent a very large part of development costs. Laboratory tests for example, on the Sperry Model A-12 Gyropilot covered a period of three years and required thousands of man-hours, in spite of the fact that Sperry had been making automatic pilots since 1912 and had produced many prior models.

Assuming that performance in the laboratory gives promise of ultimate success, flight tests will be planned and carried out. Here, careful planning and the preparation of a test pattern is doubly important because of the cost of airplane operation and the difficulty of going back to fill in missing data.

To continue the example of the Sperry A-12 Gyropilot, flight tests on the company's own planes ran to several thousand hours, and later tests on other planes, requiring the presence of Sperry engineers, involved several hundred additional hours of flying.

Even on such a relatively simple device as the Kollsman Angle of Attack Indicator (shown in Fig 3) initial flight tests required 50 man hours of installation and 30 hr. of flying. A further series of tests on a military type plane took 200 man-hours of installation and 60 hr. of flying. Computations and analysis of the results accounted for another period of about 150 man-hours.

If the first experimental unit is found to be somewhat less than perfect, its re-design is next in order, then comes the reconstruction of the unit or the building of an entirely new one. Even if the first unit could be altered, building of a new one is often desirable, so that comparisons may be made between the two models, should the second one exhibit some fault not observed in the original test. Laboratory tests of the second unit must be as thorough as those of the first, for it is unsafe to assume that the changes made to correct one fault may not have altered another characteristic which was originally satisfactory. Then the scene shifts to the airplane, where flight tests will be repeated.

Redesign, reconstruction, and retest may have to be done again and again, but the pattern remains as described; and eventually, one hopes, the head of the research and development department will place the completely successful experimental model on the chief engineer's desk and say, "This is it."

At this point, the production engineers go to work, and here we have one of the most crucial moments in the life of the new device, for human factors play as large a part as things technical or scientific. The baby is acquiring foster parents, with accompanying emotional stress. The utmost cooperation is necessary between those who conceived, designed, and tested, and those who will redesign for production. The production man cannot know, unless he is told by the men who did the development, whether the shape of a part may be changed to facilitate production, or whether it was made that way after many trials. Close fits in an experimental model may be quite impossible in production, through accumulation of tolerances.

Complete redesign may be required to obtain, in production, limits resulting from hand fitting in the experimental model. Between the details which cannot be changed and those which must be changed, there may be many which the production man will want to alter to conform with standard shop practices. He will also avoid parts which are almost but not quite symmetrical, and which therefore might be reversed in assembly, etc. From much give and take will come a product retaining the features of the experimental unit, but with parts designed for economical fabrication and assembly.

We are now approaching the end of the process of creating a new instrument. From the production drawings at least one prototype will ordinarily be made. Frequently it will be desirable to make a small pre-production quantity in a jobbing or small-quantity shop.

Of the prototypes, the first will go to the laboratory for repetition of the tests which were made on the experimental units, then to the airport for final flight tests, after which this instrument (or one of the identical prototypes) is ready for submission to the customer.

Finally, unless the original specification was drawn with more than ordinary prescience, the customer, sales, research and development, and production people will get together on revised specifications which management will accept as the criteria for that product.

All these 22 distinct steps in the research process (see accompanying table) take time and cost money. During the war, many research and development expenses were inextricably merged with production costs, giving research a "free ride." But now research must have its own budget. Unless there is adequate appreciation of the cost of research and development, instrument makers and their customers are both heading for trouble.

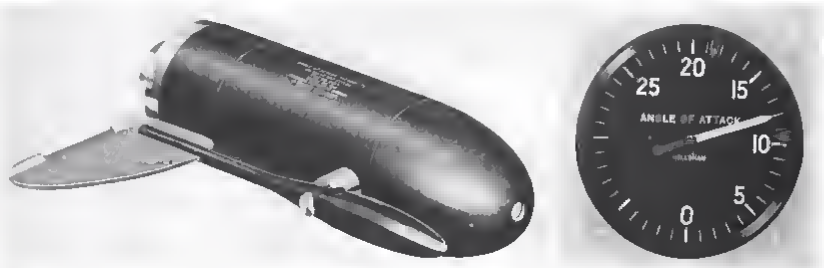


Fig. 3. This angle of attack indicator—device and dial—required total of 250 man hours for installation alone. Then flight testing took over 90 hr., after which 150 hr. were expended in computing and analyzing results.

Develop Potent Rocket Engine For Navy's Supersonic Planes

New light liquid-fuel power plant, rated at 6,000 lb. thrust, is culmination of four years of research for BuAer by Reaction Motors, Inc.

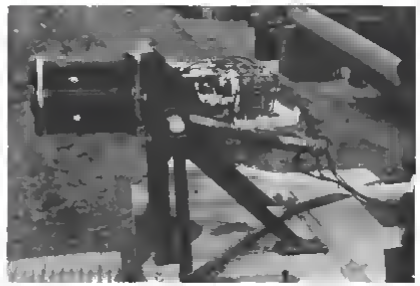
DESIGNED EXPRESSLY to power supersonic aircraft, a new liquid fuel rocket engine weighing but 210 lb. and said to be capable of delivering 6,000 lb. thrust at sea level has been developed by Reaction Motors, Inc., of Pompton Plains, N. J., in conjunction with the Navy Bureau of Aeronautics.

Designated the 1500N4C, the engine basically consists of four cylinders, each capable of delivering 1,500 lb. thrust. Each cylinder contains an igniter combustion chamber and expansion nozzle. The propellents consist of a specially developed alcohol compound for fuel, and liquid oxygen as an oxidizer.

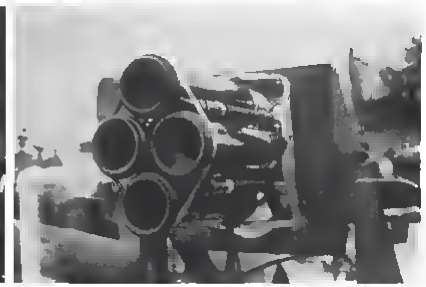
This development paralleled that of the German Walter rocket engine used in the Me-163. However company officials state that the new engine is so much more powerful that if it were employed in an Me-163 the craft would be destroyed. Far greater operating efficiency is also claimed for the 1500N4C.

At the present time, rocket engines provide comparatively short duration of power because of their extremely high fuel consumption. It is notable, however, that since they carry their own oxygen for combustion, no atmospheric limitation on their operational altitude is seen.

Flame spurts from engine as one combustion chamber is activated. Ignition is by means of an electric arc. At left is operator at control stand. At right are fuel tanks, large silver tank containing liquid oxygen and dark slim one holding alcohol mixture. (Aviation photos.)



Mounted on test stand, Reaction Motors new 1500N4C rocket engine displays its compactness. Its size belies its power. Company officials state that it produces 6,000 lb. thrust at sea level. Notable is frost (caused by temperature differential) on pipes carrying liquid oxygen.



Expansion flare of nozzles is evident in this view of engine's four cylinders each of which contains an igniter combustion chamber. Company has spent four years in developing this power plant for Navy supersonic fighter planes.

LIQUID MASS MEASUREMENT UPS FUEL GAGING ACCURACY

By CARL H. ODELL, *Assistant Manager, Instrument Division, Thomas A. Edison Industries*

Increased payload—instead of extra fuel—is only possible when tank gages can be depended upon to give accurate readings. Described here is new device which approaches optimum in liquid measuring through electronic determination of C. G. of liquid at any airplane position.

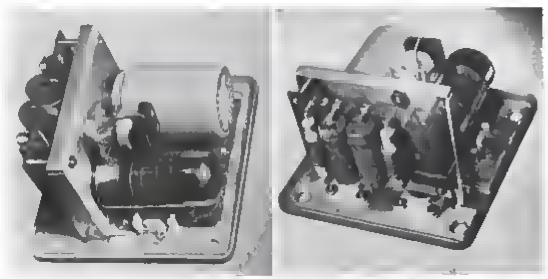
EVEN IN THE DAYS when airline travel seldom comprised non-stop distances of over 1,000 mi., study of the effect of fuel weight on payload was a full time job for competent engineers. Now that transocean flights have become commonplace, this subject is of paramount importance in the air transport field.

A considerable proportion of the excess fuel which normally is carried on long distance flights would not be required if inaccuracies in measuring the contents of the tanks while in motion could be overcome. It has been estimated that a fluid measuring device which would enable this excess fuel weight to be reduced by one half would permit an additional payload revenue of $2,500 on an Atlantic round trip.

Though closer accuracy can be obtained by measuring weight, rather than volume, this method is not applicable to moving aircraft, but a near approximation to the true contents of a tank can be had by measuring mass instead of cubic contents.

Mass determination by capacitance change indication has recently been used for fuel measurement with a high degree of accuracy, and because of the small amounts of current involved fire hazard has been eliminated.

The Edison Liquid Gaging System is fundamentally a capacitance bridge with a ratiometer across the bridge (see Fig. 1). One leg of the bridge comprises the measuring condenser plates immersed in the liquid to be measured, while the second leg is a fixed condenser used for reference. The other two legs are the R.F. coils in the vacuum tube circuit (see Fig. 2).



Two views of simple, electronic transmitter used in Edison Liquid Gaging System. This device receives micro-ampere current from tank units and transmits variations to indicator on instrument panel.

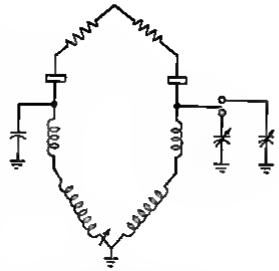


Fig. 1. Bridge circuits of Edison liquid measuring system. On left is reference circuit which has same capacitance as fully immersed measuring circuit on right. As fuel (or other liquid being measured) is withdrawn from tank, bridge becomes more and more out of balance and ratiometer indication varies directly with relative capacitance. Water gaging circuit (extreme right) is cut in by pressing button.

Capacitance of the fixed reference condenser is equal to that of the measuring condenser when fully immersed, but any lesser amount of liquid in the tank will produce unbalance between the two legs of the bridge, this differential being used for the purpose of operating the indicating means.

A test circuit and water detection circuit incorporated in the indicator are actuated by pressing a button, thus providing the pilot with a means for checking the functioning of the gaging circuit at any time, and without interference with the flow of fuel to the power plants.

Absence of any moving parts (except the moving magnet in the indicator) and the use of micro-ampere current give this gaging system extreme reliability and safety.

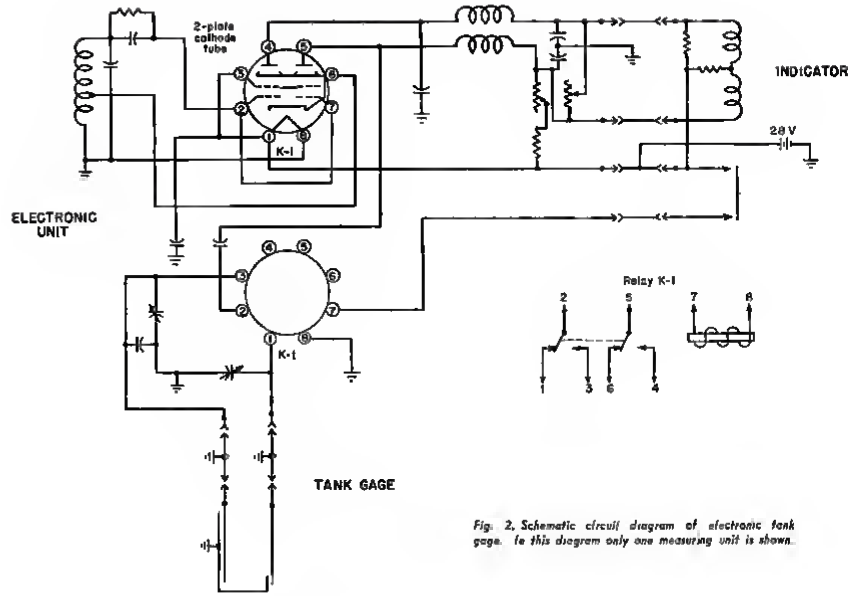


Fig. 2. Schematic circuit diagram of electronic tank gage. In this diagram only one measuring unit is shown.

Because this device uses mass rather than volume as a basis of measurement and because mass can be regarded as being concentrated at the C.G. of a body, it is only possible to obtain close accuracy by locating measuring devices as close as possible to the C.G. of the liquid (see Fig. 3). The C.G. is also constantly changing, both through movement of the position of the airplane and because fuel is being withdrawn by the engines. For these reasons, the position of the measuring devices must be determined to suit each individual tank shape and size, since a slight error in the placement of one unit might nullify the exactness of the rest of the installation.

Tank elements are condenser plates, insulated to form a dielectric gap. Variation of capacitance of these elements is adapted for each installation. For the majority of tanks, which are of unsymmetrical form and have a variable liquid drop, profiled sheet angles have been found to offer the greatest variation in capacitance changes. Because the overall accuracy of any remote measuring device is no better than that of the actual measurement, the shape of the condenser elements is designed to give a capacitance equal to the mass at any point, and these elements are so located that tilt conditions do not materially affect the linear capacitance-mass relationship of the fluid contents of the tank.

Readings are independent of temperature, altitude, barometric changes, or the attitude of the aircraft. Surges caused by transient accelerations, either linear or angular, have only an instantaneous effect with respect to the indications.

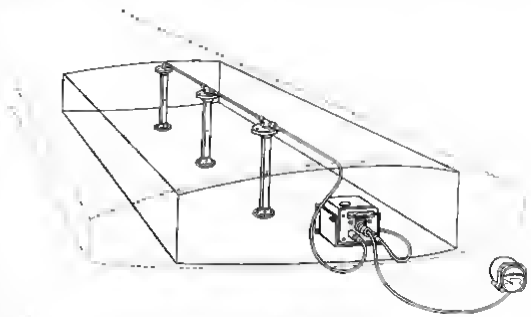
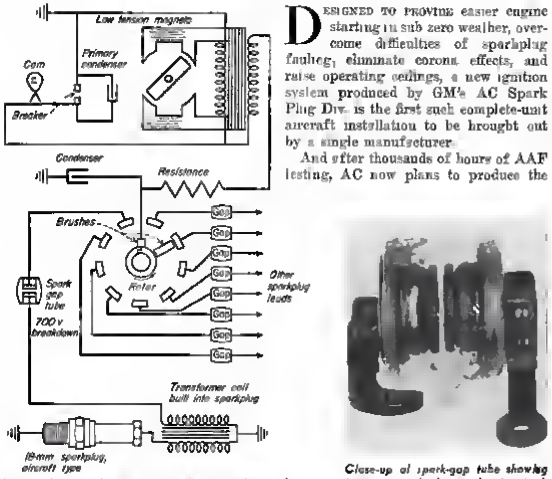


Fig. 3. Cutaway view of gage installed in aircraft wing fuel tank. Center measuring device is at C. G. of mass when approximately level. Outside units are at C. G. of mass at ends of tank, thereby giving more accurate indication when tank is tilted. Number and location of units depend entirely upon shape of tank. Electronic unit is shown on end of tank. Indicator may be located in any convenient position.

Unit System of Ignition Aims at Better Performance

Ingenious installation—complete with low tension mag, distributor, spark gap tube, wire, harness, and transformer type sparkplug—is AC's answer to engine operation ills.



Wiring diagram showing low tension magneto, spark-gap tube and transformer type sparkplug used in new AC aircraft engine ignition system.

DESIGNED TO PROVIDE easier engine starting in sub zero weather, overcome difficulties of sparkplug fouling, eliminate corona effects, and raise operating ceilings, a new ignition system produced by GM's AC Spark Plug Div. is the first such complete-unit aircraft installation to be brought out by a single manufacturer.

And after thousands of hours of AAF testing, AC now plans to produce the installation for commercial transport planes.

Low tension magneto is used, interchangeable for size with standard H T unit, but differing from latter in windings and distributor construction, and by addition of a condenser and cold cathode breakdown (spark gap) tubes.

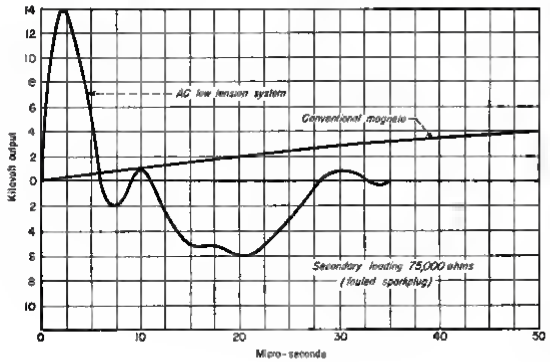
Current from magneto is delivered to brush type distributor head, from which leads go to each breakdown tube (equipped with special barium electrodes with gap set for spark to jump at 700v) and to sparkplug. Encased in the ceramic insulator of the latter is a miniature step up transformer.

Electrical energy generated by the magneto is stored in condenser until supply is great enough to jump tube spark gap, delivering a surge of current to the transformer in the plug.

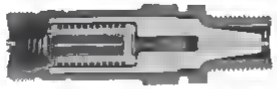
Engines using this ignition system have been run 500 hr. without cleaning or re-gapping of plugs, and electrode wear has been approximately .003 in./100 hr. service.

Close-up of spark-gap tube showing large area of plates, also terminals which attach it to distributor head and sparkplug lead.

Seen here is distributor head on AC low tension magneto with its metalographite brush which makes positive contact for distributing current to cylinder. On one terminal is mounted spark-gap tube and similar units are used on each sparkplug lead.



Performance curve showing tremendous speed with which sparking current builds up to maximum voltage, compared with that of conventional high tension system. Note that latter has not reached ½ voltage when current has been flowing ten times as long as with new system.



Section of new AC sparkplug featuring tiny transformer built into ceramic insulator. Plug of 18 mm. size is interchangeable with standard aircraft plugs.

Instrument Shock Mount Adapted for Personal Planes

Low-price suspension type giving three-way vibration absorption is designed for current-craft installations and components. Meantime, larger units are being supplied for airliner uses.

UTILIZING A BACKLOG of experience obtained in building more than 200,000 shock mounts for combat aircraft, Robinson Aviation, Inc., has developed a line of units for personal and commercial planes. Employed is the company's Vibrashock principle (first described in Nov. 1944 AVIATION).

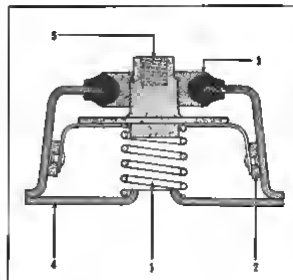
This principle provides for three-way freedom of movement, designed to absorb more than 90%—actually it is closer to 100%—of all vibration, taking up shock in both horizontal and vertical planes. In some conventional mounts a vertical shock, for example, can be absorbed but lateral movements will actually be amplified.

The new Robinson mounts utilize a stainless steel coil mainspring, four flat springs working against the mount housing to kill low frequency oscillation and minimize resonance at critical frequencies, three way snubbers providing a resilient stop to limit heavy shock loads, and a load carrying central stud which is tapped for standard machine screws.

The mount base has standard attachment holes, and the unit is designed to be interchangeable with conventional mounts so that no redesign is necessary for installation in either current equipment or in aircraft. Some panels can be successfully mounted with but two of the units and a stabilizer. For example, C. S. Robinson, president of the company, has mounted the flight instruments in his own Fairchild 24 on two of the units, on an either side, combined with a stabilizer at the top. His radio is mounted on four units, one at each corner, with a stabilizer at the top. Flight demonstrations conducted for an AVIATION correspondent showed almost complete vibration absorption through all engine speeds and in taxiing over a rough field.

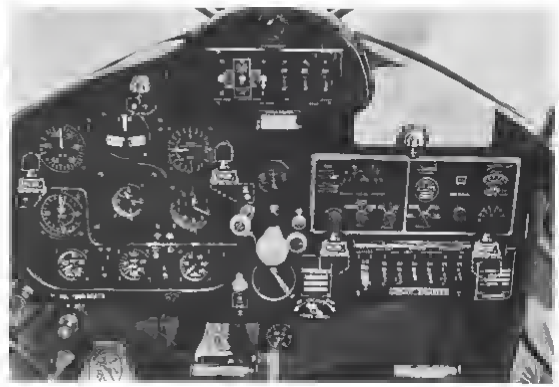
Currently the company is producing the Vibrashock units in three series—one ranging from rated loads of 0.5 to 4 lb.; one from 4 to 12 lb., and another from 10 to 45 lb. The smallest unit weighs 0.60 oz., while a typical unit in the second series weighs 1.77 oz.

While the smallest shock mounts have been designed especially for radios and instruments of personal planes, the larger units are being installed in radio units of many airliners where continuing service tests have already passed the nine-month mark without tube failures, whereas tube life had formerly averaged but ten days.



Cross section of Robinson Vibrashock unit, showing (1) three-way freedom of main stainless steel spring unit (2) damper cart attached to flat spring for cutting low frequency oscillation and minimizing resonance at critical frequencies (3) rubber snubbers to provide resilient stop to limit heavy shock loads; (4) lightweight metal housing provided with standard attaching holes in base and (5) load carrying stud tapped for standard machine screws.

The larger units are also being used to shock-mount the cabin supercharging and ventilating equipment of a new airliner now under development, and Robinson engineers are working with designers of another forthcoming airliner to determine the possibility of shock-mounting the entire passenger cabin within the fuselage, not only to reduce vibration, but to further soundproofing.



Cutaway view showing installation of flight instrument panel (left) and radio (right) in Fairchild 24. Instrument panel is mounted on two Vibrashock units, one on each side with stabilizer at top, while radio is mounted on four units with stabilizer.

Case For The Full-Pneumatic System

PART II

By **JAMES L. DOOLEY,** *Project Engineer Harvey Machine Co.*

Concluding his cogent presentation, the author analyzes system weight factors, outlines service and experimental air gages, and finally details typical air systems for large twin-engine and light single-engine craft.

IT IS EXTREMELY DIFFICULT to compare accurately the weights of the three auxiliary power systems—hydraulic, electric, and pneumatic—since complete information is seldom available and factors must be assumed. Because of this, any weight-comparison studies between these systems must be approximations, and they show trends only. Power generation, transmission, storage, and consumption are compared separately.

Curves are not available for comparing the compressor and unloader with a hydraulic pump and pressure regulator or with an electric generator and voltage regulator, because so few models of air compressors for aircraft service have been built.

In general, the compressor for the pneumatic system will weigh about twice as much as the pump of an equivalent hydraulic system. It should be emphasized that this comparison is for an equivalent system and not per unit of output power. However, extra compressor weight is more than offset by other savings. Since the demand for light-weight, high-speed compressors is comparatively recent, it is reasonable to assume that the compressor weight will be reduced as the art of building these aircraft type units progresses and new designs are brought out—a situation similar to the development of aircraft hydraulic and electrical systems.

Power transmission is compared in chart shown in Fig. 6 of Part I (page 70 May AVIATION). Fig. 7 (Part I, same page) and Fig. 15 herewith not only show that pneumatic energy can be transmitted with the efficiency and weight of hi-cycle a.c. power, but also that high pressures are not required as in a hydraulic system. Obviously, these curves will vary somewhat with different insulation and tubing materials, but they do show that air is more than competitive.

Weight comparison of energy storage devices is shown in Fig. 5 of Part I (page 70 May AVIATION). When energy is withdrawn from a battery at the slow drain rate, there is considerable weight advantage over a pneumatic receiver or hydraulic accumulator. However, in almost every instance the energy is required rapidly—in some cases, almost instantly. When the withdrawal rate is high, the total energy obtainable from a battery is as low as 15-20% of the maximum obtainable when the withdrawal rate is low.

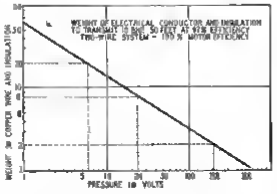


Fig. 15. Graph of power transmission

In an air receiver this is not so. The air receiver (and hydraulic accumulator) can give up *almost* as much total energy instantly as when withdrawn slowly. Actually, there is cooling of the air because of adiabatic expansion when the withdrawal rate is high, reducing the total energy available. The amount of cooling depends upon the expansion ratio. This is a material advantage for receivers (and accumulators) in aircraft use, where engine starting and landing gear operations are short-time heavy loads.

Also, low temperature adversely affects battery operation. The energy available not only falls off rapidly with lower temperature but at such temperature the battery cannot be fully recharged. In a receiver the pressure drops because of contraction during cooling, and the energy available is thereby lowered, but the unit can be recharged to full pressure.

Weight comparisons of rotary motors are shown in Fig. 16. All of the electrical units are for intermittent duty, whereas the hydraulic and pneumatic motors can stall under load and stand without damage. Pneumatic motor size, even for low pressures (80-250 psi.), is small—a 5 hhp. 8,000 rpm. vane type motor using 250 psi. air pressure being of about 2½ in. dia. and 4½ in. long.

A pneumatic cylinder will weigh slightly more than a hydraulic cylinder (less oil) for the same job because built-in lubrication is required and, also, the diameter is larger. Contrary to the condition in hydraulics, where the weight of oil in a cylinder varies inversely with the design operation pressure, pneumatic cylinders require the same weight of air to handle a given force and stroke regardless of design operating pressure. Higher pressure cylinders are smaller and have less volume, but the air is more dense.

For example, the handling of 10,000 lb. force with 1-ft. stroke requires a 5-in. bore and 500 psi. air pressure, with cylinder volume of 240 cu. in. at this pressure (0.35 lb.). The variation in metal weight of cylinders with pressure depends upon so many factors, including the whim of the designer, that it is difficult to make a direct comparison. In the range from 300 psi. up, it has been found that properly designed large-bore low-pressure cylinders are only slightly heavier than small-bore high-pressure units for the same job.

Most cylinders are designed to withstand full receiver pressure even though satisfactory operation requires much less. Obviously, for this low pressure, large-bore cylinder steel walls of proper thickness are, from the stress viewpoint, much too thin to be practical in manufacture or use. This indicates that aluminum, magnesium, or even plastic-bonded material should be considered to obtain minimum cylinder weight. Some of these materials may stand up without lubrication and be corrosion resistant.

Aircraft Uses of Air

There are three major factors which influence the design and application of aircraft equipment using compressed air:

1. Air has practically no lubricating properties, since most oil and water are removed in receivers. Hence, all equipment must be either self- or non-lubricated as well as corrosion-resistant.
2. Air is compressible to a much greater extent than hydraulic fluid.
3. Water vapor is taken into system by compressor and must be controlled to prevent malfunctioning of equipment because of freezing at low temperatures.

However, the use of compressed air in the aircraft installations listed below shows how versatile this fluid actuating medium can be when properly applied. Asterisks are used to indicate those units for which air has been employed in actual service, whereas most of the other installations specified have been air actuated experimentally.

1. Landing wheel brakes.*
2. Landing gear actuators.* (Also for combined retraction and springing for lightplanes.)
3. Tailskid.
4. Wing flaps.*
5. Cowl flaps.*
6. Dive brakes.
7. Remote valves.
8. Starters for reciprocating engines and gas turbines:
   a. Air injection starter.*
   b. Pneumatic motor-driven inertia starter.
   c. Direct-cranking air turbine.
9. Gun charger.*
10. Water rudder.
11. Installations requiring static charging:
    a. Engine ignition harness.*
    b. Pneumatic tires.*
    c. Oleos.*
    d. Tanks (lubricating oil).*
    e. Electronic equipment.*
    f. Water seals around wheels and other amphibian units.*
12. Bomb bay doors.*
13. Fairing for gun turrets.*
14. Windshield cleaner (power driven wiper or direct air jet).
15. Remote position indicator (transmitter and pressure gage).
16. Transfer pump.
17. Cargo and bomb hoists.
18. Ejector type bilge pump.
19. Instrument drives.*
20. Wing folder.

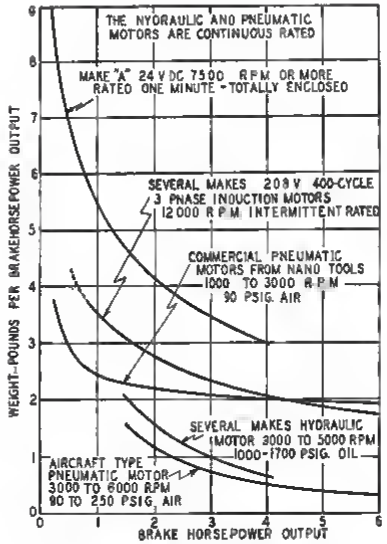


Fig. 16. In this graph are shown weight comparisons of rotary power units

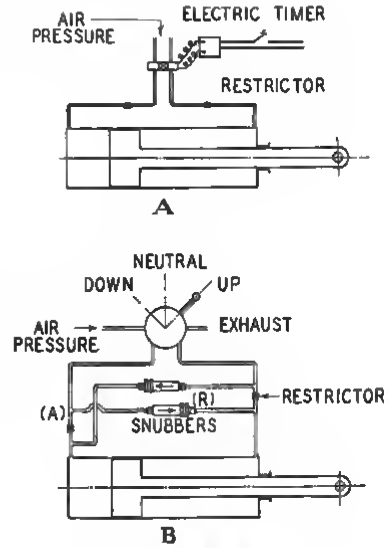


Fig. 17. Schematic diagrams showing methods of injecting cushion air charge

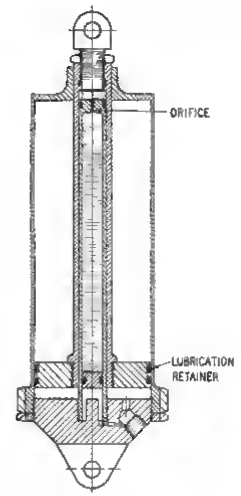


Fig. 18. Diagram of air cylinder with hydraulic damping

21. Signal horn *
22. De-icer boots *
23. Engine controls *
24. Floats
25. Automatic pilot (all pneumatic) *
26. Remote reading pressure gage
27. Propeller featherers

Employment of compressed air in all of the foregoing items falls into one of the following classifications of application

1. Linear motion
   a. Non-positioning
   b. Positioning
   c. Boosting (follow up positioning with load feel)
2. Rotary motion
   a. Unidirectional
   b. Dual rotation
   c. Positioning
   d. Boosting
3. Displacement
4. Signaling
5. Direct application of air jets

It is almost essential that the load-stroke characteristics of an installation be known before the best type of control for the cylinder can be selected. Since cylinders and pistons are generally used for linear motion, let us consider the various means of controlling them. With pneumatic damping or snubbing, two basic types of air cylinders are used:

1. Light air cylinders, where control is such that normally no pressure is applied and cylinder is at atmospheric pressure. When operation is initiated, pressure is applied to one end of cylinder (only until movement is completed), then it is withdrawn. This frequently allows cylinders to be made with little or no packing, without serious leakage, since air pressure is only applied for very short periods.

2. Dense air cylinders, where air pressure is always applied to one side of piston or other. Better cylinder and packing design is required for this type. In some applications, better control of piston movement and/or simpler valving is afforded. When pressure is required to hold piston at either end of its stroke, dense air cylinders are used.

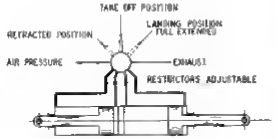


Fig. 19. Diagram of wing flap air cylinder with positive mid position.

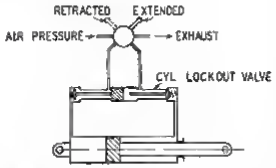


Fig. 20. Sketch showing application of cylinder lockout valve.

To control either of these cylinders, compressed air is *metered* to one end of the cylinder while the exhaust is *metered* out the other end. In the dense air cylinder there is always adequate cushion air to meter out, but with the light air cylinder, where only atmospheric pressure is present on the "down" side of the piston, there is not enough cushion air to meter out to insure smooth operation. This is especially true where fast action, such as opening of bomb bay doors, is desired at high altitudes.

To prevent such condition, some compressed air is put into one end of the cylinder for cushioning, before air is applied to the opposite end for movement. This may be accomplished by using, 1. solenoid valve with automatic delay and reversal, as shown in Fig. 17a, 2. manual valving, or 3. automatic pneumatic one-shot snubbing valve as shown in Fig. 17b. For movement to the right (see figure), full air pressure is applied at (A), from where it flows unrestricted through valve (R), filling the right end of the cylinder, to, say, 100 psi, whereupon it closes and stays closed until all pressure is removed. At the same time, air is being metered into the left end of the cylinder through a restrictor. As this pressure increases and the cushion charge in the right side is metered to atmosphere, the piston moves slowly to the right under most load conditions. The air lost in this cushioning charge is negligible.

There are some load conditions where pneumatic cushioning cannot be used. Air cylinders can be built with integral hydraulic (Fig. 18) or mechanical snubbing, widening the scope of application considerably.

The foregoing discussion applies mainly to full-stroke non-positioning applications. Positioning jobs can be handled with air cylinders when there is no tendency to flutter or where the fluttering is sufficiently damped. Here, again, small built-in hydraulic control can be used with the air cylinder for power, where damping is required. A pneumatic motor with reduction and ball bearing jack screw can be used, but usually is heavier and more costly. Special cylinder and control equipment is available in the industrial and marine fields to do this remote positioning with only two interconnecting control air line and an air power supply line. This is being adapted to aircraft work and already is used experimentally for control of multiple engines.

In some cases, a single mid-position is all that is required—as in wing flap actuating cylinders—and can be accomplished with two cylinders, back-to-back, as shown in Fig. 19. Because the wing flaps must be held both out and in by air pressure, this job inherently requires a denser air type cylinder.

An interesting application of a compressed air cylinder is that in a retractable tail-skid or tailwheel installation, wherein compressed air is locked in the cylinder in the extended position and forms the cushion or pneumatic spring. This is done with a lockout valve similar to that used with hydraulics (Fig. 20).

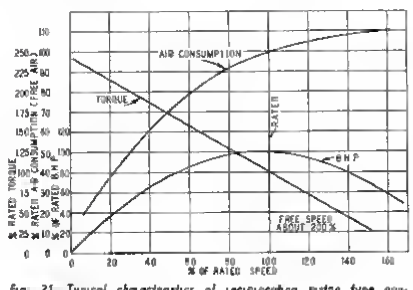


Fig. 21. Typical characteristics of reciprocating piston type non-reversible air motor.

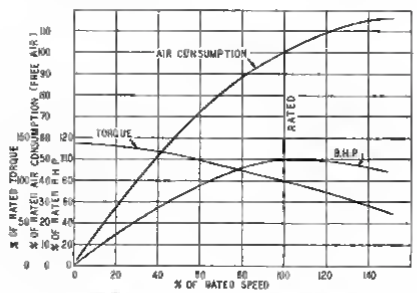


Fig. 22. Characteristics of rotary vane type air motors (non-reversible).

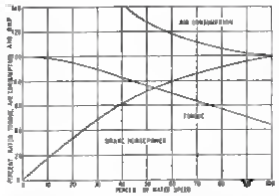


Fig. 23. Characteristics of impulse turbine.

Air Motors

There are four basic types of pneumatic motors: 1. Reciprocating piston—in line, radial, "V", barrel, and others; 2. rotary vane, 3. turbine—usually impulse type; and 4. gear or lobe.

These units are well-known, hence will not be described here. Typical performance characteristics of the first three types are shown in Figs. 21, 22, and 23. The gear types are not generally used as motors because of leakage and inefficiency. Many types of small air motors are in mass production for hand-held pneumatic tools. These units compare very favorably on a weight basis with other aircraft motors (Fig. 16). Some models may be used for aircraft installations, but not all types are 100% positive starting and others will not run without lubrication, hence, proper selection should be made.

Pneumatically released brakes are frequently applied to air motors and turbines for industrial hoists, and similar equipment could be used for aircraft service if the need arises.

To eliminate the large lines required to handle the exhaust air from a remotely controlled reversible air motor, a small reversing valve, as shown schematically in Fig. 24, may be used. This simple slide valve diverts the exhaust to atmosphere, right at the motor, hence the long air lines need only be large enough to handle the high pressure motive air.

Air Jets

In addition to the obvious displacement uses of air, there are jobs that employ an open air jet because the air is not returned to the system after use. Typical of these is the ejector shown schematically in Fig. 25. Here, air is used as motive power to compress the inlet air or to pump a liquid, such as bilge water. Another use of high velocity air is for cleaning windshields—particularly curved installations where the normal blade wiper cannot operate properly. In this case, a small jet of high pressure air is directed over the area to carry away the water and dirt. Fluids used to prevent icing can be blown on the windshield, the air blast not being seen by the pilot.

It is desirable to keep a pneumatic system tight, not only to maintain the pressure for the brakes when parked, but also to have as much air available as possible for starting the engines. A pressure tight system can be achieved with a properly designed system. It should be noted, however, that a leaky system is not hazardous, merely inconvenient. One of the greatest sources of leakage is the valves—unless they embody soft seats, are of the poppet type, and are not perfectly balanced (that is, some seating force is required). Metal-to-metal seated poppets and spool- or sliding-valves have never been made completely pressure tight on air. Fig. 26 shows the relative amounts of power that can be dissipated through small leaks in pneumatic and hydraulic systems. Obviously no such power loss can be tolerated continuously.

Sliding seals in hydraulic-system valves may be satisfactory, but in a pneumatic system, where there is little or no lubrication, experience indicates that sliding seals cannot be used in closely balanced valves because of eventual stickiness. The present hydraulic valving on the market can only be used satisfactorily for air when it meets the requirements indicated above.

Pressure Reducing Valve

To store pneumatic energy in a receiver, the pressure must be higher than that required by the various devices using air. The greater this permissible pressure drop, the more efficiently the receiver is used. Practical restrictions limit the pressure drop in most cases to ½-¾ maximum permissible receiver pressure. For example, a system designed for 1,000 psi maximum storage pressure would have landing gear retraction cylinders that would function satisfactorily on about 600 psi applied pressure, thus permitting a 400-psi pressure drop, in the receiver, from which to get power. When a cylinder is designed large enough to function on 400 psi, and full receiver pressure is applied to it, not only is the speed of operation slightly faster but much more air is used than is necessary.

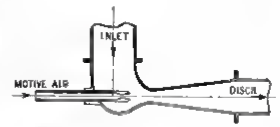


Fig. 25. Diagram of air jet ejector pump.

This extra air is particularly objectionable when several operations of the cylinder are desired with no compressors in operation, all air coming from the receiver. To conserve this extra air, a simple reducing valve is installed that maintains 450 ±50 psi downstream. In most applications of this nature,

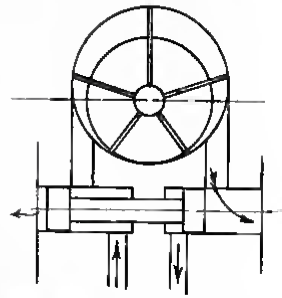


Fig. 24. Diagram of reversing valve for air motor.

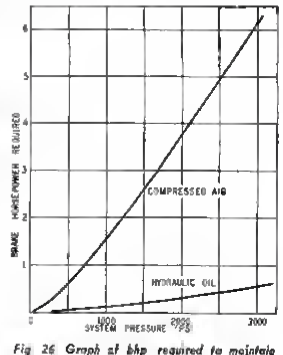


Fig. 26. Graph of bhp required to maintain leakage through 1/64 in. sharp-edge orifice.

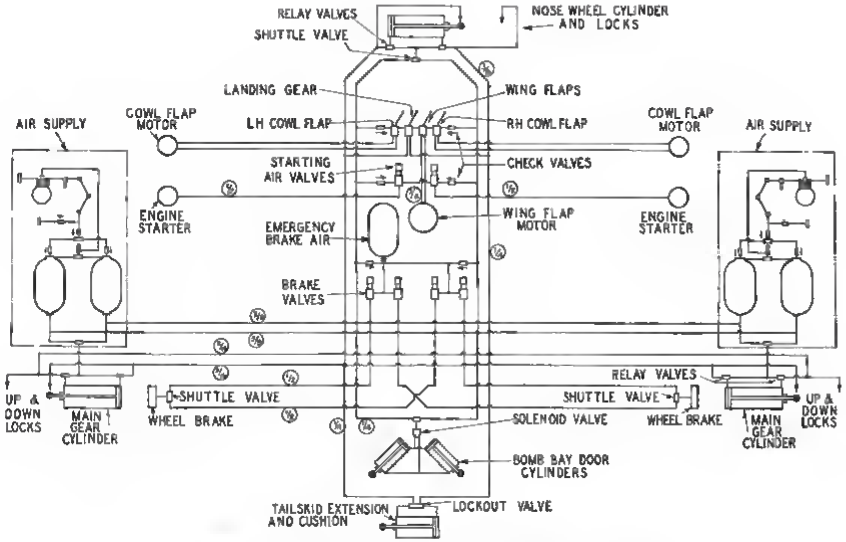


Fig 27. Schematic diagram of pneumatic system for large-twin-engine plane.

ruggedness, simplicity, and lightness in the valve are more important than accuracy of control. Safety valves should be installed on the downstream side of the valve unless all equipment is designed for full working pressure.

Typical Systems

Fig. 27 shows a pneumatic system layout for a large twin-engine plane. Main lines and receivers are all in duplicate to reduce vulnerability and enhance reliability, and a separate receiver is available for emergency brake application. Either compressor may charge the entire system, or either half of the system. The receiver selection valve will divert flow of air to the intact receiver should the other be damaged, and the latter will automatically be recharged and put into service when it is repaired. In this layout, pneumatic control is carried to the pilot, but solenoid operated valves could be used, if desired, although they are much heavier. Brake valves are provided for both pilot and co-pilot, but it is assumed that the other controls would be on a common control stand. Bomb bay doors are controlled electrically with a solenoid valve. Approximate line sizes are also shown.

The tailskid uses the air in the cylinder not only for extension and retraction but also for cushioning, when extended. This eliminates a heavy and expensive oleo shock-absorber or spring. Manual cowl flap control is shown, although automatic control is easily accomplished.

In contrast, Fig. 28 shows a typical pneumatic system for a small four place

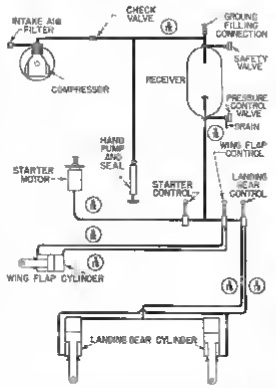


Fig 28. Schematic diagram of pneumatic system for single-engine personal plane.

175-bhp. single-engine personal plane. Reliability, low cost, and simplicity are imperative here. The system is designed for engine starting, landing gear operation, and wing flap control. Weight is about 40 lb., and cost is below that for competitive methods for doing these jobs.

A ground filling connection is provided so that the receiver may be charged from any tire filling station, and a manual pump is included for an isolated start when air pressure has been spent. Only about 50 psi is required for a normal temperature start. Normal maximum system pressure is 200-300 psi., since a single stage compressor is used for simplicity.

In all planes—especially small craft—pneumatic power works hand-in-hand with a.c. hi-cycle electric power. Pneumatics are at their best where a.c. systems are not feasible. Conversely, a.c. systems are best for radio work, where air cannot be used. There has been considerable attention given recently to lightplane constant-voltage variable-frequency hi-cycle a.c. systems for reasons of weight-and-cost reduction. Pneumatics complete such a power system.

The several advantages we have here considered—notably that of weight saving—predicate an increasing use of compressed air in aircraft.

*Strain Analysis Quickly Finds Formability Limits**

PART II

By **GEORGE GERARD,** *Senior Research Engineer, Republic Aviation Corp.*

Concluding article of this pertinent series, giving application to joggling by means of both formulas and experimental results.

AN EXPERIMENTAL INVESTIGATION of the method for predicting minimum bend radii was made on 0.064 in. Alclad 24ST, Alclad 75ST, and R 301T aluminum alloy specimens.

Bend tests on various width specimens were performed on a power brake in which the radii were varied in 1/32 in. steps. The specimens were bent 90 deg. to different radii close to the minimum, producing fracture in some specimens and satisfactory bends in others. Thus, the minimum bend radius was bracketed by the widths tested. Results are shown on Fig. 9.

Strain-gage length characteristics of the materials used in the bend tests were determined, and they will be noted in Fig. 8 (Part I, page 75 Apr. AVIATION).

* Based on paper presented before Society for Experimental Stress Analysis. First installment appeared on page 73 of April AVIATION.

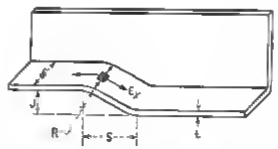


Fig. 10a. Method of determining joggle parameters.

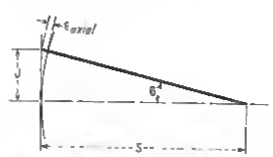


Fig 10b. Axial elongation due to joggling.

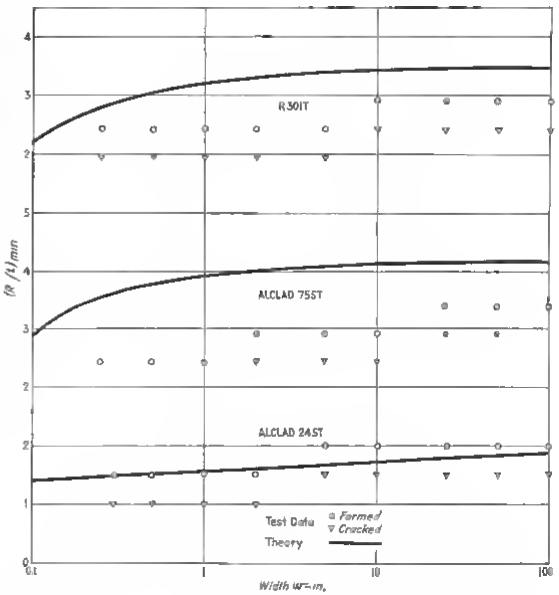


Fig. 9. Agreement between theory and test data on variation of minimum R/t with width.

Experimental and Theoretical Juggling Limits

0.072 in. Alclad 75ST
At Room Temperature

t in.	S in.	Formed in Shop	J/S	ϵ_{max} Fig. 11b	ϵ_{max} Fig. 11b $R/t = 3.83$	γ_1	θ deg. Fig. 11b	L in.	ϵ_{act}[a]	Theoretical[b] Prediction
1/8	3/8	OK	0.333	0.056	0.140	0.106	18.5	0.080	0.203	OK
3/16	3/8	CR	0.500	0.125	0.140	0.267	26.5	0.178	0.182	CR
3/16	1/2	CR	0.375	0.070	0.140	0.211	20.5	0.090	0.196	CR
3/16	5/8	CR	0.300	0.0450	0.140	0.165	16.5	0.060	0.209	OK
3/16	3/4	OK	0.250	0.031	0.140	0.171	14.5	0.068	0.218	OK

[a] Determined from strain-gage length curve corrected to 1 in. width
[b] OK means formed; CR means cracked
ϵ_{act} is the theoretical strain required for given joggle dimensions and ϵ_{max} is maximum strain particular material can sustain without fracture — hence if $\epsilon_{act} < \epsilon_{max}$ part will form successfully; $\epsilon_{act} > \epsilon_{max}$ part will fracture.

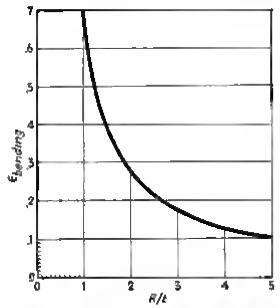


Fig. 11a. Bending strains imposed by joggling.

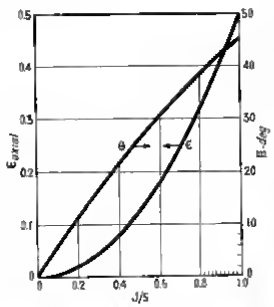


Fig. 11b. Axial strains caused by joggling

tion). The basic curves, corrected for widths of 1 in. and 100 in., include the correction for the cladding thickness given by Eq. 7 (Part I). These data were then plotted nomographically, as shown in Fig. 5 of our article "Determining Bend Radius—Via Analytical Approach" (page 165 of Mar. 1945 AVIATION). And using this method, minimum bend radii for the different widths were computed.

Test and Theory Check

Theoretically determined radii are presented on Fig. 9 together with experimental data. Agreement of Alclad 24ST data is good, although for the other two alloys the variation of R/t with width as predicted by theory is conservative as compared to test results. In all cases, agreement between test and theory is very good at small width values. The latter points were established from the basic bend analysis and are negligibly affected by the empirical correction established for the width effect. Further study of the width effect may alter Eq. 8 (Part I) so as to bring the width variation of bend radius in closer agreement with test results.

The basic agreement among the results

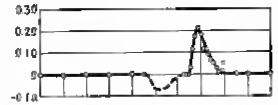


Fig. 12. Strain distribution along center line of 3/16 x ⅜ joggle

indicates that in spite of the complexities inherent in a theoretical solution of this problem, rational results can be obtained by the methods employed.

Joggling

A rather interesting application of the strain analysis method is the extension of the minimum bend radius work to the analysis of a joggle based on the assumption that failure will occur at the bend. Furthermore, the strain in the region of curvature is composed of a maximum tensile strain at the outer fiber due to bending, superimposed upon a uniform tensile strain distribution caused by stretching of the metal in the joggle length S in Fig. 10a. Maximum tensile strain from bending is determined as before, with consideration of width effect.

Tensile strains from joggling are assumed to be confined to the joggle length S. Therefore, from Fig. 10b

$$e = \sqrt{S^2 + J^2} - S$$

The axial strain is obtained by dividing by S

$$\epsilon_{AXIAL} = \sqrt{\frac{S^2 + J^2}{S^2}} - 1 \qquad (11)$$

By use of the binomial expansion, Eq. 11 reduces to

$$\epsilon_{AXIAL} = \frac{1}{2}\left(\frac{J}{S}\right)^2, \qquad (12)$$

when J/S is in the range of joggle dimensions usually employed.

Summing the tensile strains from bending, Eq. 3 (Part I) and axial load, Eq. 12, the maximum tensile strain

$$\epsilon_{MAX} = \frac{K}{R/t} + \frac{1}{2}\left(\frac{J}{S}\right)^2 \qquad (13)$$

The joggle angle, θ, is identical to the angle of bend of Eq. 4. From Fig. 10b

$$\theta = \tan^{-1}\frac{J}{S} \qquad (14)$$

Figs. 11a and 11b have been prepared to simplify solution of Eqs. 13 and 14. On Fig. 11a, the tensile strain from bending is plotted as a function of the ratio of neutral axis radius to sheet thickness. Fig. 11b depicts the axial tensile strain as a function of the joggle dimensions, J/S. A plot of the angle θ has also been included.

Photogrid Survey

To check the basic assumptions of the analysis, photogrid surveys were made along the centerline of several joggles. A strain distribution along the joggle is shown in Fig. 12. The survey indicated that the forming strains imposed in joggling are confined to the joggle length S and that maximum tensile strains are attained at the bend at which point cracking usually occurs.

Experimental Data

A further check on the analysis was performed by determining joggling limits on some 0.072 in. thick Alclad 75ST "Z" stringers joggled at room temperature. The neutral axis radius of the joggle was 0.276 in. Thus,

$$R/t = \frac{0.276}{0.072} = 3.83.$$

Results of the shop joggling tests and those predicted by the analysis are presented in the accompanying table.

References

1. Shanley, F. R., "Elastic Theory in Sheet Metal Forming Problems", July 1942 *Journal of the Aeronautical Sciences*.
2. Jackman, K. R., "Super-Aluminum Alloys for Aircraft Structures", Aug., Sept., and Oct. 1943 AVIATION.
3. Gerard, G., "Determining Bend Radius—Via Analytical Approach", Mar. 1943 AVIATION.

Controllable Lightplane Prop Is Easily Adjusted and Serviced

Specifically designed for the lower horsepower range, Continental's new two-position Skypower airscrew is readily installed without use of special equipment. Here, the simplicity of its operation and of its maintenance is carefully detailed.

WITH THE ADVENT of higher wing loadings in the personal plane field, aircraft propeller designers saw realization of notable takeoff, climb and cruising economies through use of controllable pitch propellers in place of the solid ones formerly fitted. Latest of this type is the Skypower propeller made by Continental Aviation & Engineering Corp., Muskegon, Mich. This unit is for firm's 65-85 hp. engines.

There is a natural desire to maintain comparatively low prices for single engine lightplanes, hence use of a propeller of the more complex type, such as used on the larger multi-engine aircraft, has not been considered, for it would represent a cost too high in proportion to the total. Therefore, a simpler-form airscrew was sought.

The propeller here described is actuated by two stationary expansion chambers—shown at (4) and (5) in Fig. 1—either of which can be connected to, and extended by, oil from the engine lubrication system, while oil is withdrawn from the other chamber. Between these is a stationary disk attached by a ball bearing to a sleeve which is linked to the rotatable blades. By moving a simple four way valve, the pilot can direct oil pressure into whichever expansion chamber he desires, thereby rotating the blades into high or low pitch. Because there are no rotating oil joints or seals, positive action is assured and danger of leakage is absent.

Referring to the details in Fig. 1. Rotating blades (1) are carried on ball

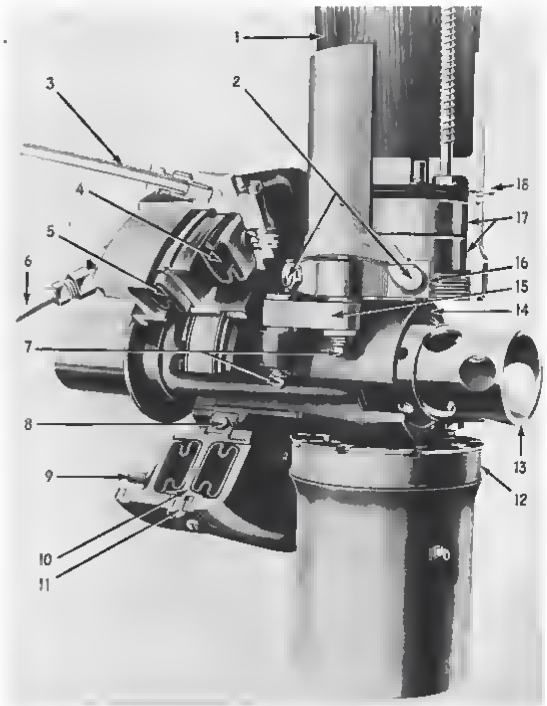


Fig. 1. Cutaway view of Skypower two-position controllable pitch propeller showing (1) laminated birch blade, (2) blade angle adjusting capscrews, (3) low pitch oil line, (4) low pitch actuator, (5) high pitch actuator, (6) high pitch oil line, (7) linkage pins and grease fittings, (8) actuator ball thrust bearing, (9) mounting stud, (10) actuator stationary disk, (11) high and low pitch actuator stops, (12) blade ferrule, (13) hub nut, (14) hub, (15) link, (16) altitude adjustment, (17) renewable ball bearings and (18) ferrule grease fitting.

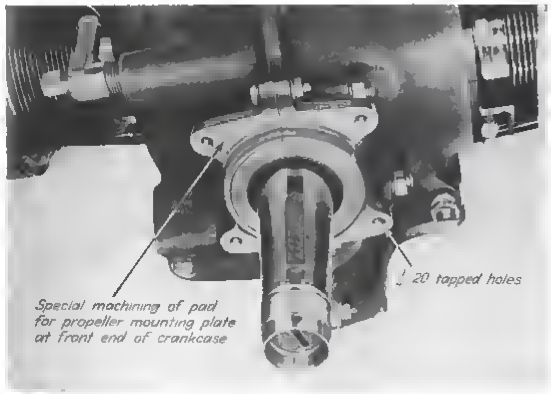


Fig. 2. On older models of Continental engines special machining was required for fitting propeller brackets. At upper left is breather fitted with elbow for oil return from actuators while at lower right is straight reducer and elbow for pressure connection from engine oiling system to four-way valve.

bearings (17) which may be renewed without removing blade from ferrule (12). On circumference of ferrule is adjustable fixture (15) which transmits motion to the blade. The position on the blade of these fixtures may be changed—while stationary—to make high and low pitch positions of the blades conform to the requirements for the varying atmospheric conditions obtaining at different airport altitudes.

Connected to an arm on each ferrule is link (15) which rotates the blades when transfer unit (10) is moved back and forth by expansion of either low pitch actuator (5) or high pitch actuator, (4), which are connected by their respective oil lines (6) and (3) to the engine oil system. Motion of actuator (10) is transmitted through ball thrust bearing (8) to a collar which slides on outside of hub and is attached to one end of each link (15) controlling blade rotation.

From the foregoing it will be seen that the entire oil system is closed and has no wearing parts, with the exception of the slight motion of the actuator against the casing, a movement which occures only at the time when blade pitch is changed, the total travel being only a fraction of an inch.

Propeller Installation

On earlier Continental engines it is necessary (see Fig. 2) to machine the front end of the crankcase and drill and tap four ¼-20 holes for capscrews which hold the mounting plate bracket. Tapered bore of hub and mating surface of shaft are then given an even, light coating of clean grease, after which the propeller assembly is placed on the shaft, care being taken to align the key and keyway. In this operation it is essential that the oil connection—shown at (12) Fig. 3—be on top.

Entire assembly is then slid back until the hub nut—(13) in Fig. 1—can be engaged. While doing this, the four supporting studs—(9) in Fig. 1—are aligned with the corresponding holes in the brackets. The hub nut is then tightened with a round bar, and nuts are placed on mounting plate studs. At this point the machined pilot-face of the mounting plate should be checked to make sure that it fits squarely against the machined face of the crankcase.

Control Valve and Oil Lines

For installation of control valve and oil lines refer to Fig. 3. Four-way valve and its bracket assembly is mounted on top of engine at (5), being secured by crankcase bolt (9). Two pipe plugs at (11) and (12) are removed, and straight tube connectors (supplied with propeller) are inserted in the openings. All threads on these and other connections should receive an application of non-hardening oil-resistant sealing compound. The two end threads on all internal joints should be kept free from sealing compound, because this material has a tendency to creep while the joint is being tightened, and any excess compound would enter the engine oiling system. Being oil resistant, sealing compound will spread upon and clog screens.

The pipe plugs are of no further use until the unit is disassembled at a future date, when they should be used in their original positions to prevent entrance of dirt. This precaution also applies to the four protector plugs removed from the four-way valve, at (3), (4), (6), and (7) to permit installation of straight tube connectors, this being the next step.

Remove pipe plug from front crankcase left side oil header at (11) and install the ⅜ to ⅛ reducer bushing and connector elbow provided with propeller.

Next remove breather elbow (15) and drill and tap ⅛ pipe thread at (16), then replace. Connect four oil lines in following order: Constant pressure line (10) from crankcase at (11) to valve at (6); alternating pressure line (8) between valve at (7) and actuator at (12), line (14)—carrying alternating pressure—from valve at (3) to actuator at (13), and drain line (1) which returns oil from valve at (4) to breather (15). In applying sealing compound to these eight joints, same methods and precautions should be used as were indicated for installing pipe connections.

Control cable and bracket are then installed, bracket being held by crankcase bolt, with eye on bracket turned toward case. Drill ⅜ hole through instrument board and firewall and assemble control cable through the hole. Clamp tubular cable jacket in clip and connect wire to four-way valve at (2), first pushing knob on instrument panel inward until it touches surface of panel, also moving control lever on valve to full forward position. Under these conditions, blades will assume low pitch position when, later, oil pressure is applied by running engine.

Inspection and Checking

With propeller control set in low pitch position by pushing knob on instrument board forward as far as it will go, start engine and check all tube connections for tightness. Any leakage can be better observed if all joints have been wiped clean before starting. If leakage appears at tube connections, they may be tightened cautiously, but if any oil seepage appears around points where connections have been screwed into the crankcase or valve body, the pipe joints must be loosened before these ports are further tightened. It should be remembered at all times that pipe fittings, though amply strong for the work they have to do, are easily broken by application of too much force when tightening. In many cases the damage will be in the form of invisible cracks, which become permanent leaks as soon as oil pressure is applied, grounding the plane until these fittings are replaced.

With wheels blocked, run engine at full throttle and check rpm. on tachometer, comparing this speed with take off rpm. specified by manufacturer. It should be remembered that a two position propeller, when running on the ground in low pitch, will impose a slightly greater load on the engine when in climb or level flight and, therefore, engine rpm. will be lower on the ground than when in the air. Consequently, ground rpm of prop should be adjusted to permit maximum engine speed in climb, otherwise if propeller is adjusted on the ground for maximum speed there will be danger of excessive rpm. in flight.

To accomplish this adjustment to give best possible flight results, it may be necessary to make several short test flights. If rpm. is too high or too low, blade angle should be changed until speed is correct.

One degree of change in pitch angle will change speed approximately 90 rpm. This fact greatly simplifies blade angle adjustment, because angle of change can be figured by dividing 90 into the difference between actual and desired rpm.

Angle of blade is measured by means of a bubble protractor or inclinometer, using the following method: (a) Turn propeller to horizontal position, (b) place blade in low pitch position, and (c) hold protractor against blade at reference line marked on driving face at edge of plastic coating, making a record of reading. To guard against false readings because of position of plane on ground, turn second blade, before measuring, into position occupied by first one when its angle was measured. For instance, if blade No. 1 was measured on the right hand side of plane, then the second blade should also be measured in that position.

To change pitch angle, set protractor to angle required, then remove lock wire from capscrews—(2) in Fig. 1—which hold link fitting (16) to ferrule. Loosen capscrews and turn blade to correct angle, checking with protractor on reference line.

Turn propeller half a revolution to bring second blade into same position and repeat blade adjustment, also checking this blade with protractor. Tighten cap-screws with torque wrench to 60–70 in.-lb. Then check angle of both blades again with protractor and, if correct, lockwire the capscrews. It is essential, for balance, and therefore flying efficiency, that the angle of both blades should be *exactly* alike. Compensation for operation at higher altitudes is also made in this manner.

Lubrication

"Labriplate" ball bearing grease, or its equivalent, should be used for lubricating this propeller. Requiring attention are: One point on each blade ferrule, four on linkage pins, and one on actuating unit. Ferrule fittings need no attention between overhauls, but others should be greased every 25 flight-hours. New propellers are completely lubricated before shipping, hence require no further servicing before installation.

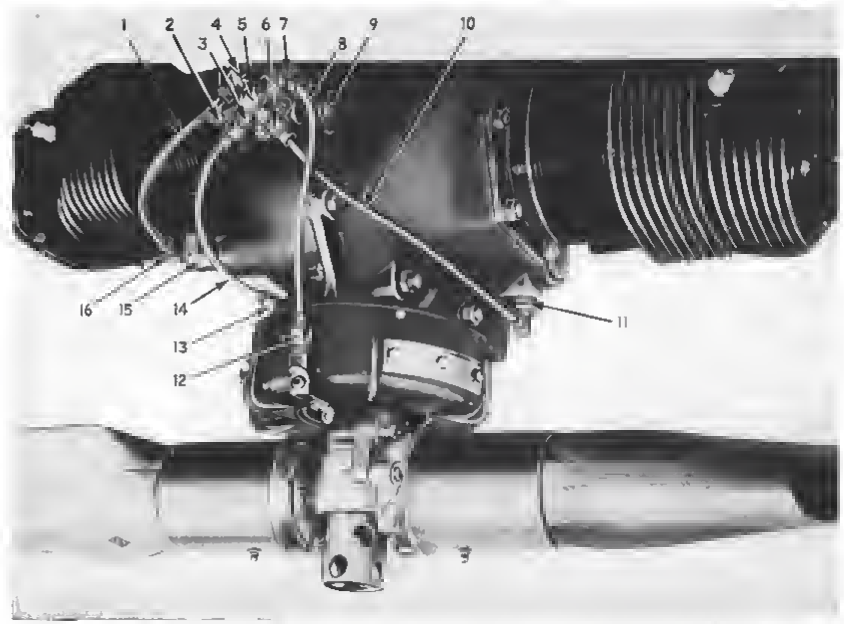
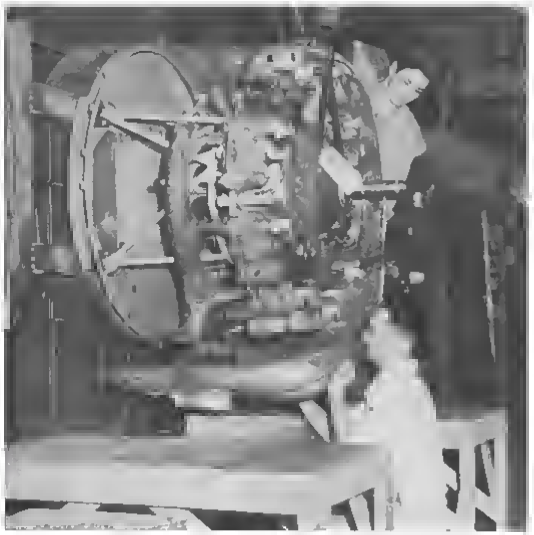
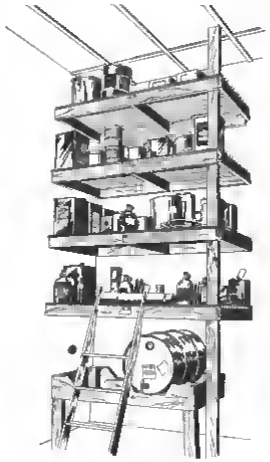


Fig. 3. Four-way valve and plumbing, showing (1) oil return to breather (2) control lever and wire (3) high pitch actuator fluctuating pressure line, (4) attachment for line (1), (5) four-way valve, (6) attachment for line (10), (7) attachment for (8) fluctuating pressure low pitch oil line (9) crankcase bolt holding four-way valve, (10) constant pressure oil line from engine oil system, (11) fitting which connects (10) to engine oil system (12) low pitch actuator oil line connection, (13) high pitch actuator oil line connection, (14) high pitch actuator oil line, (15) crankcase breather to which is fitted elbow (16) for oil return from four-way valve.



Power Plant Mockup Expedites Cowl Fitting

▲ Using old engine mount together with engine built from discarded parts, AAA has eliminated misfits in making cowling replacements. Because dimensions of mockup conform exactly to those on its airplanes, renewal cowls always fit without trouble.

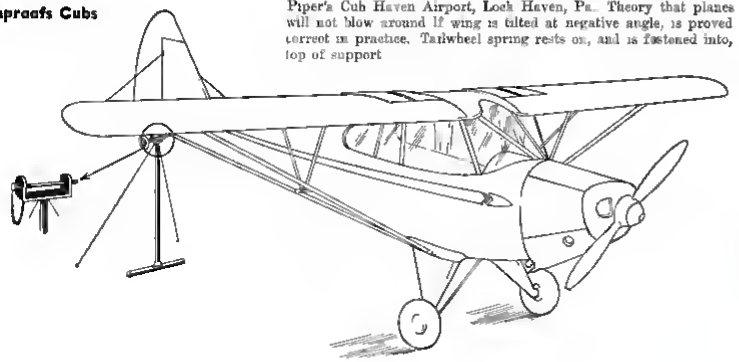


Special Paint Rack Keeps Floor Clear

▲ Eliminating any untidy accumulation on shop floor of partly used paint containers, this rack enables mechanics at C. K. Grieder's Martin's Creek Airport, Pa., to locate instantly any required finishing materials. Numbered sections permit easy segregation of items.

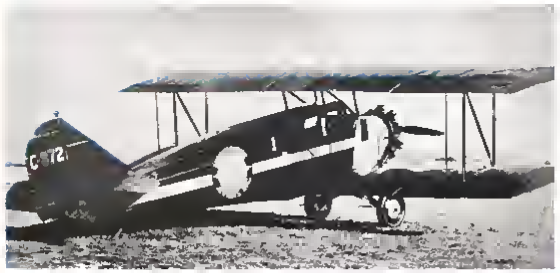
Tie-Down Fixture Stormproofs Cubs

▲ Welded together from odd pieces, this tail support is used at Piper's Cub Haven Airport, Lock Haven, Pa. Theory that planes will not blow around if wing is tilted at negative angle, is proved correct in practice. Tailwheel spring rests on, and is fastened into, top of support.

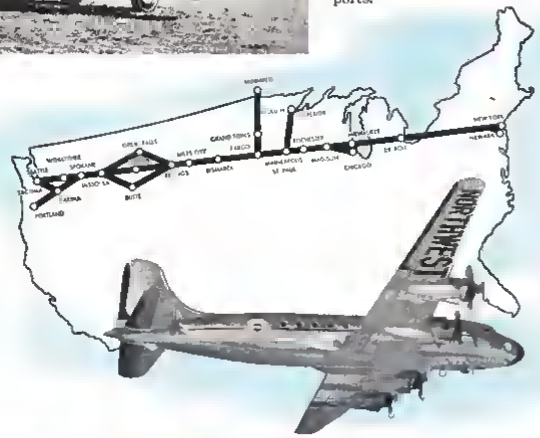


20 YEARS OVER THE NORTHWEST PASSAGE

MAKES NORTHWEST THE NATION'S SECOND OLDEST AIRLINE!



1926 One of the three Stinson-Detroiter cabin planes which flew the mail on Northwest Airway's route between Minneapolis and Chicago. Averaging 70 pounds of mail to the round trip, these planes, pioneers all, were the forerunners of today's luxurious transports.



1946 Along the Northwest Passage, coast to coast, giant 4-engine transports fly in 11½ hours. Four miles-a-minute speed, and luxury accommodations for 44 passengers are samples of even greater speeds and luxury to come

Vacationists everywhere look to Northwest Airlines to prolong holidays spent on the range, at dude ranches, in hunting or fishing

1947 Tomorrow's Northwest Airliners will begin service early in 1947. Already purchased, ten of these giant 80 passenger Boeing Stratocruisers are being built for swift 340 miles an-hour transcontinental service. And Northwest has applied for certification to send these big ships clear to the Orient.

Eighty passengers will ride in lounge chair comfort high above the weather in the pressurized Boeing Stratocruiser. The upper deck is shown above; below it, a spiral stairway leads to a smart cocktail lounge that easily accommodates 14 persons.

UNITED STATES RUBBER COMPANY

6600 EAST JEFFERSON AVE., DETROIT 32, MICHIGAN
5675 EAST ANAHEIM TELEGRAPH RD., LOS ANGELES 22, CALIF

R. I. FIRM DEVELOPS TWO NEW UTILITY 'COPTERS

Helicopter Engineering & Construction Corp. is building one-placer, to have 100-mph. top speed with 75-hp. Continental. Also scheduled is two-seater of similar layout. These craft, aimed at low-price field, are planned for simplicity of operation.

DESIGNED FOR LOW-COST, utility, and ease of operation two new small helicopters are under development by Helicopter Engineering & Construction Corp., of 2735 Pawtucket Ave, East Providence 14, R. I. Model 100, slated to be a single-placer, is now being built at Allen School of Aero at the state airport, Hillsgrove. And Model 101, intended to seat two, will be very similar in layout to its predecessor.

Flight tests of Model 100, which is to have a 200-lb baggage capacity, are expected to start in about two months. The craft will have a steel tube fuselage, covered with light plywood skin and fabric. A Continental A-75-9 engine of 75 hp. at 2,300 rpm. will be mounted just behind the cabin. A fixed tricycle landing gear is to be utilized.

Radius of the three-blade main rotor is given as 9.75 ft., while power loading is put at 10 lb./hp. and disk loading at 2.5 lb./hp. A tip speed of 400 fps. is given, while solidity ratio is to be .06. Anti-torque rotor is to be of 2.25 ft. radius.

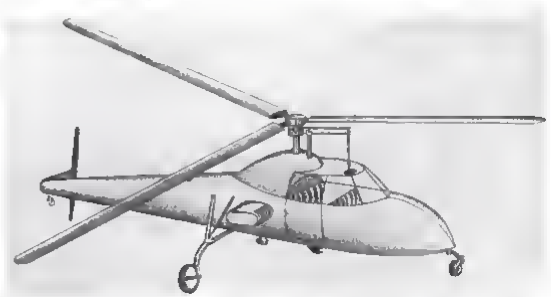
Model 100 Performance

A top speed of 100 mph. is contemplated for Model 100, which is to have a gross weight of 750 lb. and an empty weight of 350 lb. Maximum rate of climb is planned at 1,200 fpm., while maximum vertical rate of climb is to be 650 fpm. Descent velocity during autorotation along the flight path is given as 1,800 fpm.

Components for Model 101 have been designed to be similar to those of the earlier craft. However, fuselage and transmission will vary slightly in that different placement of the main rotor gear box is necessary to provide accommodation for the passenger, who is to be seated at the C.G.

Utility seen by the company for the one-placer includes its use by salesmen and for mail delivery from post office to airport. A price of about $2,000 is under consideration.

Single-place Model 100, to have 200-lb. baggage capacity, is designed for use by salesmen or for mail pickup work. Main rotor is to be of 19 ft. 6 in. dia., while tail anti-torque rotor will have 4 ft. 6 in. dia. (Aviation sketches)



Model 101, planned as a two seater, is to be basically similar to smaller model 100 'copter. Addition of passenger has dictated several modifications such as different placement of main rotor gear box and some redesign of cabin.

Craft's all-cantilever design is pointed up in this view, as is wide degree of visibility from coupe type cockpit enclosure. Gross weight is 1,675 lb., useful load is 585 lb., and baggage capacity is put at 50 lb.

Meyers Grooming Fast New Two-Placer

Wing slots and retractable landing gear utilized on law-wing craft that has stated 140-mph. top speed.

ANOTHER NEWCOMER in the personal plane field is the Meyers MAC 125-C, a side-by-side two-seater made by Meyers Aircraft Corp., Box 721, Tecumseh, Mich. The firm reports a high top speed and good cruising range for the new craft, which is now being put through its paces for an Approved Type Certificate.

Powered by a 125 hp. Continental C-125 engine, placarded top speed is given as 140 mph., cruising speed as 120 mph., and stalling speed with flaps as 45 mph. Climb from sea level for the first minute is stated to be 700 ft., and maximum range with 30 gal. of fuel is 500 mi.

Span is 30 ft., length 20 ft. 10 in., and overall height 8 ft. 8 in. Wing area is 149 sq. ft., including ailerons. Areas of other surfaces are as follows: Ailerons 5.38 sq. ft., rudder 3.69 sq. ft., fin 5.33 sq. ft., elevators 8.84 sq. ft., stabilizers 13.15 sq. ft., and flaps are each 6.67 sq. ft. Gross weight is put at 1,675 lb., weight empty is 1,000 lb., and useful load 585 lb. Wing loading is 11.24 lb./sq. ft., and power loading is 13.4 lb./hp.

Fuselage is of all-metal monocoque construction. A roomy cabin is one of the craft's features, with entrance and exit gained through hinged panels (split at the roof) which swing outward and forward. Baggage capacity is given as 50 lb. Instrumentation includes altimeter, compass, airspeed indicator, tachometer, and oil pressure, oil temperature, fuel pressure, and fuel tank gages; also an ammeter. A Delco Remy starter and Reading battery are used.

Wings and all other surfaces are of metal construction, including covering. Fitted in the wings are built-in slots (near the leading edges) and split-type slotted flaps. An NACA 23015 airfoil is utilized at the wing roots, and an NACA 23000 section at the tips. Controllable trimming tabs are fitted to the elevators, while the rudder has a ground-adjustable tab.

Landing gear is retractable and has a 115-in. tread. Hayes wheels have 6.00x6 tires. Hydraulic brakes are utilized, as are spring-oil shock absorbers.

No price for the MAC 125-C has been mentioned by the company, nor have any plans for production. At present, the oneern is engaged in building a number of Dart personal planes for Applegate & Weyant Engineering Corp.

Meyers Aircraft MAC 125-C, powered by a 125-hp. Continental, is an all-metal side-by-sider designed for a 140-mph. top speed and 500 mi. range. Main landing gear retracts inward into wells of wing roots.

FRENCH S.O.-30R BELLATRIX IS SWIFT NEW AIRLINER

Pressure cabin featured in twin-engine medium-range craft, along with tricycle landing gear and reversible pitch props. As sleeper, top speed is given as 338 mph.; with normal seating, 273 mph.

EMBODYING MANY of the latest trends in airliner design, the S.O.-30R Bellatrix is a twin-engined high-performance 16-30 passenger transport manufactured by France's nationalized Societe Nationale de Constructions Aeronautiques du Sud Ouest.

Fuselage is an all-metal semi-monocoque structure of circular cross-section, the cockpit windows being smoothly faired into the unbroken nose line. Rubber sealing is utilized, and it's stated that an internal pressure equivalent to 8,200 ft. can be maintained when the craft is flying at 19,680 ft. The cabin, divided into three sections, can be arranged to seat 30 or be fitted with 16 berths. A bar and a toilet compartment are situated near the tail. Freight is carried beneath the cabin floor and in a compartment built in each inner wing.

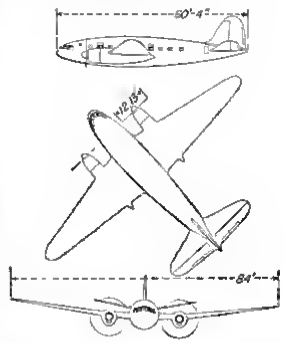
A crew of four is specified. Dual controls are fitted, and instrumentation is in duplicate. Electrical instruments are in the center of the control panel. Included is a three-phase automatic pilot. The flight engineer is seated to the left behind the pilots, and the radio operator on the right. Indirect lighting is utilized.

Power plants are 14-cyl. Gnome & Rhone 14R-5s delivering 1,700 hp. at takeoff and 1,295 hp. normally, and they are filled as quickly detachable power eggs. Electrically controlled reversible-pitch three-blade Ratier props of 12'3-ft. dia. have large spinners which extend into the engine cowls. A 24v. electrical system is used. Landing gear is retractable tricycle, hydraulically operated, and the nose wheel is steerable.

Each wing, of all-metal construction including covering, is made in two sections and has two spars. Fuel tanks, with a capacity of approximately 1,000 gal., are located in the outer wings. Tail surfaces are also all-metal, and the elevators and stabilizers are characterized by sharp dihedral.

Specifications and Data

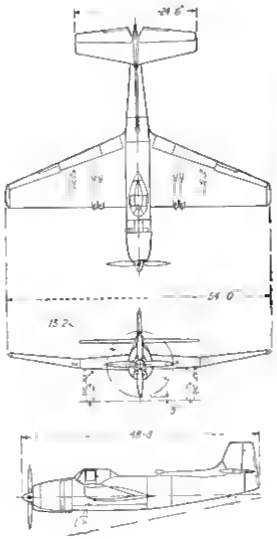
Span	84 ft.
Length	60 ft. 4 in.
Height	19 ft. 4 in.
Wing area	538 sq. ft.
Gross weight (30 pass.)	31,980 lb.
Empty weight (30 pass.)	21,714 lb.
Top speed at sea level (30 pass.)	270 mph.
Top speed at 7a 250 ft. (16 pass.)	338 mph.
Cruising speed at 19,680 ft. (30 pass.)	273 mph.
Service ceiling (30 pass.)	26,73[illegible] ft.
Range	621-1,864 mi.
Fuel capacity	about 1,000 gal.
Seating	16-30
Power plants (2)	1,700 hp. Gnome & Rhone 14R-5



Powered by two 1,700-hp. Gnome & Rhone engines, new S.O.-30R transport can carry 16-30 passengers at estimated top speeds of 270 to 338 mph., depending on seating. Craft was designed during Nazi occupation.

Heavily Gunned XA-41 Was Groomed as Ground Strafer

Though its production was superseded by a JP project, formidable Convair craft for AAF presents prime fighting and bombing capacities which are of marked interest in field of military design.



All-metal Convair XA-41 was designed as a single-seat attack plane powered by a P&W R-4360 Wasp Major of over 3 000 hp. Craft's top speed is reported as 363 mph. and its combat range as 800 mi. Armament was specified as four 37 mm. cannon and four .50-cal. guns in wings. Bomb load of 6 400 lb. could be carried in fuselage. Note unusual cockpit enclosure.

Specifications and Data

Span	54 ft.
Length	48 ft. 8 in.
Height	13 ft. 11 in.
Wing area	944 sq. ft.
Aspect ratio	5.4
Gross weight	24 188 lb.
Maximum useful load	10 852 lb.
Empty weight	13 336 lb.
Top speed	363 mph.
Cruising speed	296 mph.
Stalling speed	74 mph.
Take-off distance	1,585 ft.
Combat range	800 mi
Normal fuel capacity	350 gal
Service ceiling	29 388 ft.
Seating	1
Power plant	3 000 hp.-plus P&W R-4360

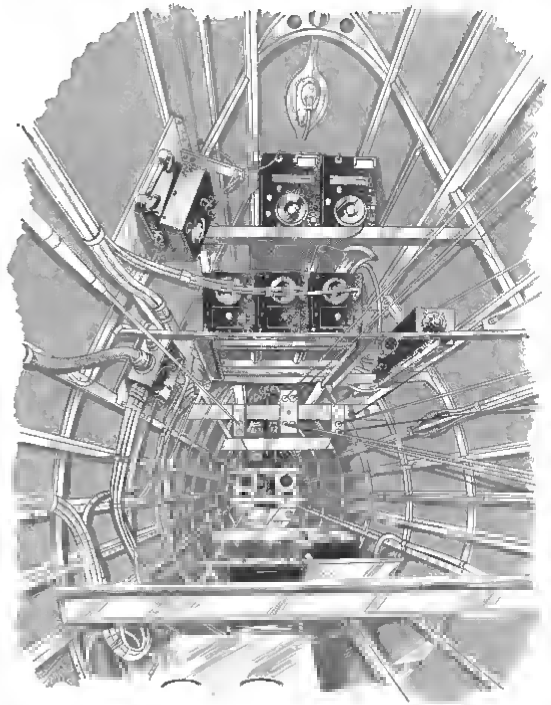
DEVELOPED in the latter stages of the war to give close aviation support to our attacking ground forces, the very heavily armed Convair XA-41 never reached the production line, all available facilities being assigned to the company's new XP-81 jet fighter (described on page 95 May AVIATION). Nevertheless, features of the plane are notable.

A single-place midwing monoplane, with conventional retractable landing gear, the XA-41 is entirely of metal construction. Powered by a 3,000-hp.-plus P&W R-4360 Wasp Major, a top speed of 363 mph. is claimed, while cruising speed is stated to be 296 mph. and stalling speed 74 mph. With normal fuel capacity of 350 gal., combat range is put at 800 mi. Span is 54 ft., length 48 ft. 8 in., and height 13 ft. 11 in. Gross weight is given as 24,188 lb. and weight empty 10 852 lb.

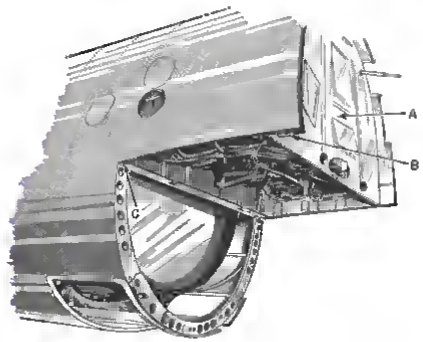
Some measure of the craft's potency may be gained from its armament—four 37 mm. cannon and four 50-cal. machine guns. Furthermore, bomb capacity is 6,400 lb., affording alternate accommodation for a torpedo.

Designed and built by Convair's Vultee Field Div., the XA-41 made its first flight on Feb. 11, 1944, at Lomita, Cal. The plane was subsequently tested by the AAF at Eglin Field, Fla., and by the Navy at Patuxent, Md.

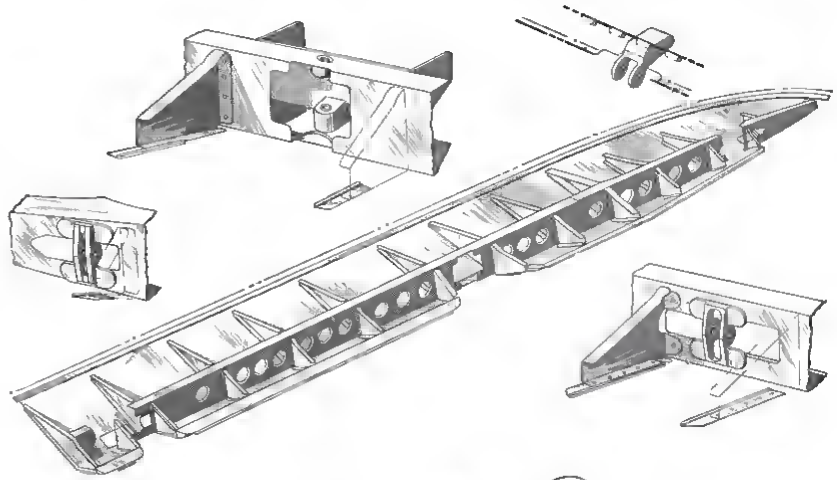
At present owned by the AAF, the craft has been assigned to the Pratt & Whitney Aircraft Corp., Hartford, Conn., where it is currently being utilized to flight test new engines.



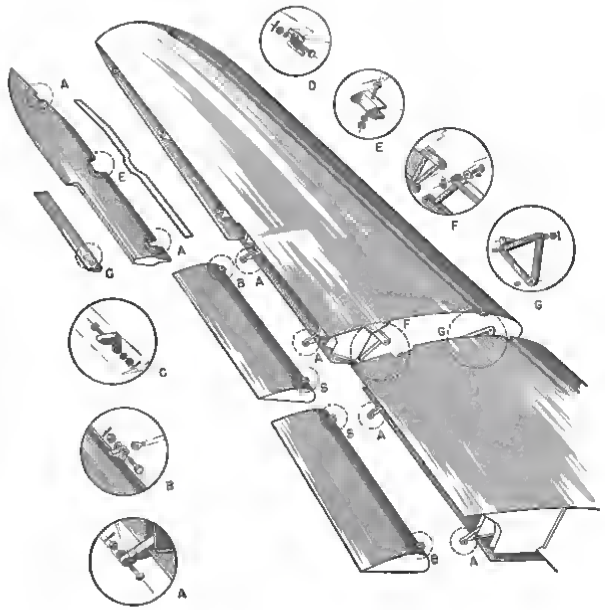
Interior view of Grummen F6F Hellcat fuselage looking aft showing elevator and rudder control cables and horizontal structural members for support of radio and other equipment.



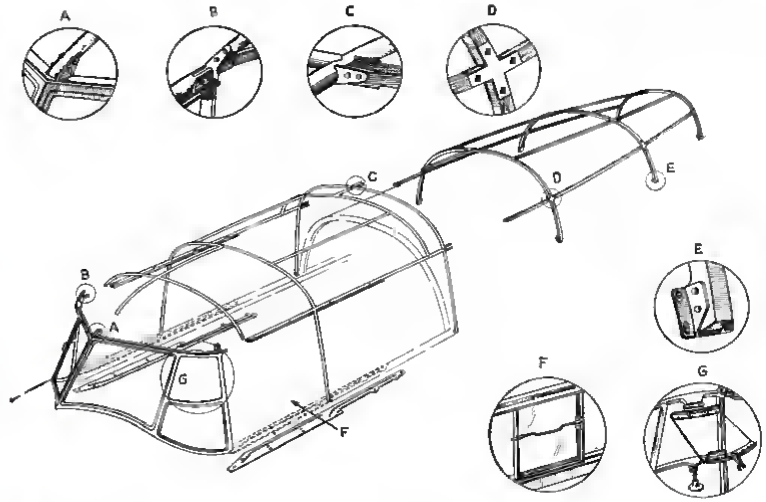
Wing of F6F attaches to fuselage at cutout below firewall (A) with front spar being bolted to fittings as at (B), and rear spar to fittings located inside fuselage at points (C).



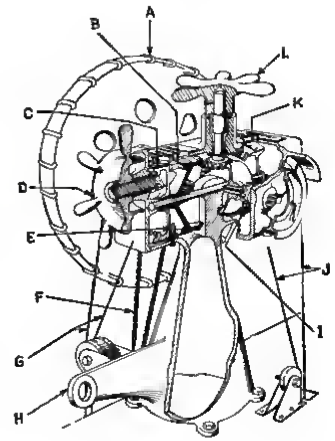
Above: Ryan FR-1 Fireball aileron comprises main spar, false spar, extruded aluminum alloy spacers, stamped ribs and flush riveted metal skin. Spars are formed of C-sections. Ailerons are hinged at three points, trim tab by continuous hinge.



Right: Exploded view showing major components of FR-1 Fireball wing, a shell type structure in which all bending stresses are taken by its single spar, and torsion by the skin, with ribs serving only to support skin contour to prevent buckling.



Cockpit canopy construction of Avro Lancaster. Illustrated at (A) is center joint of windshield frame to steel tubes forming top of structure, (B) side joint of windshield frame to steel tube, (C) joint of spruce contour frames to steel tubular structure, (D) joints in spruce frames themselves, (E) joint of spruce frame to fuselage top, (F) sliding window, and (G) small direct-vision window set in top forward part of windshield.



Cutaway view of Lancaster trim tab control box. Depicted are elevator trim tab handwheel (A), elevator trim indicator (B), aileron trim indicator (C), aileron cable handwheel and drum (D), elevator and aileron indicator stop (E), chain section of elevator cables driven by sprocket on handwheal (F), aileron tab cables (G), fulcrum for flap control lever (H), bevel gear to operate rudder trim indicator (I), rudder trim tab cables (J), rudder trim indicator (K), and rudder trim handwheal (L).

INTEGRAL SEALING RING FEATURED IN NEW RIVET

SEEN AS A STRUCTURAL CONTRIBUTION in the trend toward commercial pressurized-cabin flight is a self-sealing rivet (Figs 1 and 2) featuring a concentric hump on the underside of the head, to compensate for various factors responsible for leaky installations.

Designated by the maker, Cherry Rivet Co., as the "Keg" (from the initials of its designers—Boeing engineering process unit chief, C. P. Keeble; manufacturing coordinator, G. Eckberg, and rivet supervisor, L. Goldman) the new fastening unit effects an airtight joint by deforming the seal ring (hump) to provide sufficient surplus material to fill irregularities in the surface under the rivet head.

Originally devised for installation in the B-29 Superfortress, utilization of the Keg rivet will eliminate 1,581 ft of sealing tape weighing over 11 lb and permit attendant savings of many production man-hours. Whereas tape or compound successfully seals the B-29 fuselage, its application is troublesome and messy. Involved is surface cleaning before sealant is applied, punching or reaming of rivet holes through the tape, and cleaning up after riveting. And it's also likely that tools and hands will pick up a greasy coating.

For comparison of pressure-sealing characteristics of countersunk seal ring rivets and standard countersunk rivets assembled with and without pressure sealing tape, production and laboratory tests were conducted. Substantiating evidence resulted to prove that the seal ring rivet effects a seal comparable to that achieved with a standard unit assembled with sealing tape and provides a far better seal than afforded by standard units employed without sealing aid.

In the laboratory tests, three panels were compared, each having 50 hand-driven 78-deg countersunk rivets. First panel was prepared with seal ring rivets assembled without utilizing any sealing aid; second panel was made up of standard rivets with pressure-sealing tape, and third panel also consisted of standard units, but without any sealing aid.

Panels were tank-tested at room temperature at various pressure-time values. Seal ring rivet panels and standard

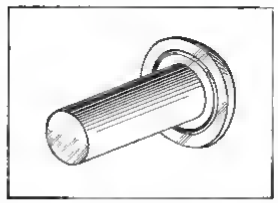


FIG 1. Underhead view of Keg rivet. The self-sealing feature is concentric ring of metal, deformed with driving to provide sufficient surplus material for tight contact.

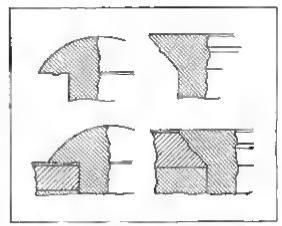


FIG 2. Top: Sectional close-ups of modified brazier and countersunk seal ring rivet heads. Above: Close-ups showing deformation of ring.

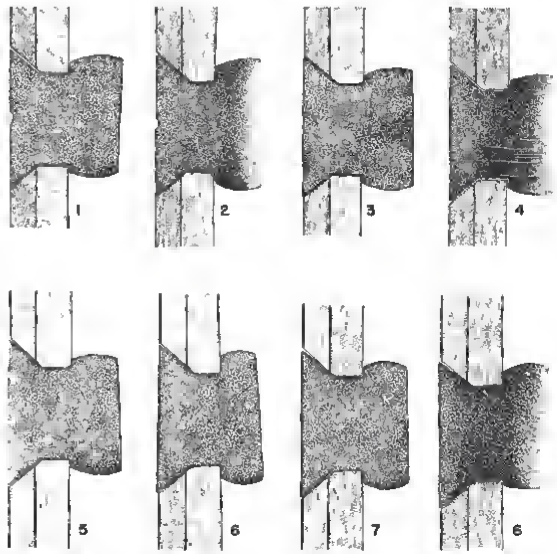


FIG 3. Top: Photomicrographic aspects of standard rivets assembled without sealing aid. Various numbered installations seen gave these leakage conditions. (1) Excessive, (2) none, (3) negligible, and (4) excessive. Above: Similar aspects of seal ring rivets; (5) No leak, and (6), (7), and (8) negligible.

unit panels using sealing tape showed negligible leakage (less than 1 cfm.). Panels having standard units without sealing aid showed leakages of 5 cfm. at pressure-time of 0.5 psi. for 15 min., 32 cfm. at 10 psi. for 30 min., 48 cfm. at 15 psi. for 30 min., 86 cfm. at 20 psi. for 60 min., 80 cfm. at 0.20 psi. (pulsating 10 cycles per min.) for 60 min., and 52 cfm. at 20 psi for 30 min.

Fig. 3 shows photomicrographic appearance of typical leaking and non-leaking rivets from panel equipped with standard units (rivets 1 to 4, incl.) using no sealing aid, and also from seal ring panel (rivets 5 to 8, incl.)

Of the former panel, cross-section of rivet (1) shows a poorly filled hole and a gap under the flush head—typical of excessively leaking rivets. Cross-section of rivet (2) shows a better filled hole and countersunk—typical of non-leaking rivets, giving evidence of better driving and correct hole size and countersunk. Rivets (3) and (4), respectively, show negligible and excessive leaking conditions.

If control of all factors responsible for leaking rivets were possible, no sealing aid would be required to seal countersunk rivets—substantiated by the result that 26 of the 50 standard units, tested in the panel without sealing aid, did not leak.

Compensating for these factors, the ring on the self-sealing rivet is deformed with driving and fills the gap under the head to provide tight metal-to-metal contact. In the seal ring panel, cross-section of rivet (5) reveals the gap completely sealed off by the deformed ring. Sections of rivets (6), (7), and (8), which showed only very light leakage, also indicate ring-sealing characteristics.

In a B-29 production structure test, with 3,500 self-sealing rivets under 0.5 psi. at 67 deg. F., only 12 rivets developed leakage—determined by brushing on a water-soap solution. Amount of leakage was negligible and difficult to determine.

CONTROL CABLE QUICK-DISCONNECT EXPEDITES MAINTENANCE ACCESS

A UNIQUE CABLE FITTING—intended for use with control cable which requires "breaking" to permit access to fuel cells, piping, or accessories—features quick-disconnection to afford cable separation at access area, and also eliminates necessity of retensioning cable upon reconnection.

Designed by M. A. Cawl, Fairchild Aircraft Div. controls engineer, the unit consists of two opposed, connected cable terminals—one being a clevis with a "knife" leg hinged at the connection end, the other comprising a fork carrying a bushed bolt.

With the terminals interconnected to transmit pull, the clevis surrounds the fork bolt bushing, the knife leg of the clevis being secured by a cotter pin to the other clevis leg at the cable end. To break the terminal connection, the cotter pin is removed and the knife leg is swung to clear the bushing and then drawn out past the bushing for complete separation from the fork.

Reconnection is simply accomplished in the reverse order, without adjustment—insertion of knife leg, swinging it down into contact with other clevis leg, and securing with cotter pin. Since the relative position of the terminals have not been altered, there is no change in cable length or tension.

Two terminals—fork (right) and clevis (left)—comprise quick-disconnect for separating cable run to afford clear access to units behind cable in craft interior. Connected to fork by bolt, clevis consists of hinged upper leg and fixed lower leg secured by cotter pin through hole visible at cable end.

Shown here, hinged clevis leg is slightly separated from counterpart with cotter pin holes visible in each. For separation from fork, hinged leg is swung up and down past connecting bolt in fork.

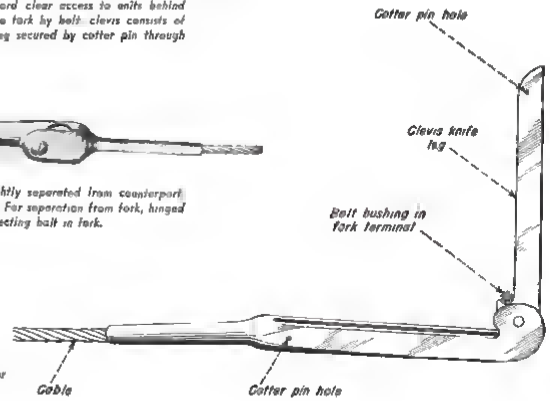
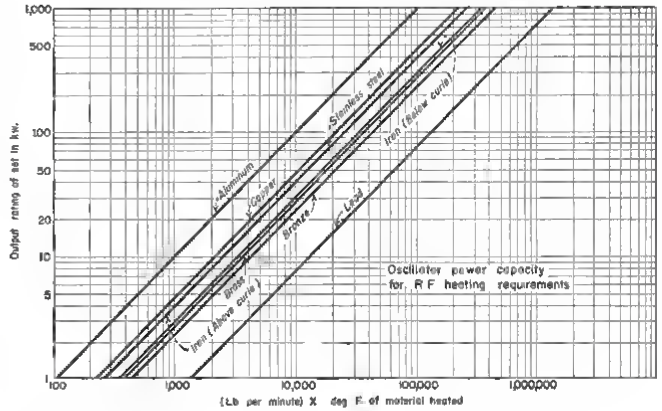
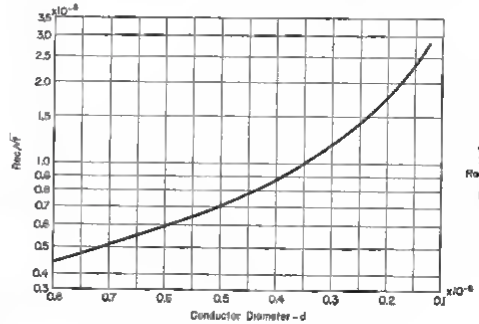


Diagram of clevis terminal in open position for separation from fork bolt

SHEET NUMBER D-35 (cont'd)
CLASSIFICATION Induction Heating
SUB CLASSIFICATION Conductor Capacity

Induction Heating Data





A.C. Resistance of Cylindrical Copper Conductor

$$\frac{Rac}{\sqrt{f}} = \frac{.35 \times 10^{-6}}{d}$$

d=Diameter of conductor (inches)
f=Frequency (cycles/sec)
Rac=Ohms per inch of conductor

Note:
Resistivity of copper taken to be $\rho = 1724 \times 10^{-8}$ Ohm-Cms

SIDE SLIPS

FOR A MINUTE yesterday, we were practically out of the publishing business and into airport operation—and boy did we feel good for that minute. It happened this way: One of our associates came barging in with a catalog and said, "How'd you like to buy a surplus airport, but really cheap?" Grabbing said catalog, we dived to the page which the index listed for airports, and sure enough there it was—"Airports, new, good condition, $30 each, in lots of 20–50, $12 each." But then we read the description: "Brass, 15 in. dia., with 1-in. thick glass, deadlight, and 5½-in. spigot."

Wish to goodness those sailors would learn to call a porthole a porthole.

• We just received a publicity handout reporting on a telegraphic "feud" between a couple of Chambers of Commerce, Junior style, as to where flying really was born in this country. The boys are, of course, trying to get their respective Chambers in the papers, but more obviously are being used to further the promotion of a forthcoming movie. Maybe we're getting old and stuffy, but we couldn't help thinking how much more useful both chambers would be if they spent the same time and effort on constructive programs to increase personal flying now—and tomorrow—in their communities. That's a job that needs some work, the movie'll make money with or without them.

• The young lady had just successfully passed a check flight, her ticket was in good order. All of which made it easy to dally in the afternoon sunshine and postpone—just a few minutes longer—returning to the airport from which she had rented the plane. On the way back, as sometimes happens, she got herself completely lost and, as she later wrote in her report, "a dark cloud suddenly descended" upon her. Somehow she got the ship down in the only available open space—on a big lawn near what looked like the main building of quite an estate. Climbing out of the ship, she wandered through the first door and found herself in a cafeteria occupied only by a husky gent in the usual white coat. Approaching him she said, "Excuse me, I just had to land my plane on your lawn and I want to ..." Patting her paternally on the shoulder, he replied, "That's all right, little girl—you just sit down and have something to eat, and then I'm sure the doctor will take care of you." Yep, she had landed on the grounds of a private mental institution, and she says she was almost nuts before she got out.

• The Colonel blew his top when the Waco control tower operator reported for duty at his advanced fighter base. Wimmin, he figured, had no place being there, anyhow, he sure didn't want one messing things up from the tower. But, since orders were orders, he finally agreed to give her a chance, even though he was certain she couldn't handle the job.

Then, the first time the boys upstairs heard her voice, one of 'em immediately shot her a call, "Red bird tower, red bird tower, this is Buck Rogers at 50 000 ft., may I have landing instructions?"

Without batting an eye she cracked back, "Red bird tower to Buck Rogers, circle the earth twice—Flash Gordon just overshot the field."

• We've just read a four-and-a-half page—single spaced—"letter" from an airline press agent saying farewell to a plane on which his line made much of its reputation. The writing would have done credit to a Hollywood soh sister—almost. For in all the four and a half pages there is nothing but the line's own name for the ship—not one single mention of the type of plane it was; not one solitary mention that a manufacturing company had designed and built the ship. Can't you imagine how that generous soul's poor heart bled as he said farewell?

"No, those aren't inspection panels—Maguna's caught in the fabric shortage."

THE AVIATION NEWS

ELAINE STUBBLEFIELD, Washington HERB POWELL, New York E. J. KULBAN, New York

Federal Airport Act Signed by President; N-S Safety is Promoted by CAR Part 42

. . . Pogue bid to PICAO . . . AAF engineering center gets a wary eye . . . Energy is Bikini prima point . . . Service merger still halted . . . Air policy bill hits hurdle . . . Most surplus craft sold

Pres Truman signed the Federal Airport Act, authorizing expenditure by the government of $500,000,000 for more than 3,000 new airports in the next 7 yr with matching funds to be provided by local legislatures.

This will be the nation's first planned effort to provide for a civil airport system and to boost the general use of airplanes for personal travel. CAA will pass on applications for Federal funds with local governments handling actual construction themselves, through contractors or otherwise. Some difficulty may be encountered because of Veterans' Housing Program Order No. 1, recently issued by the Civilian Production Administration.

Falling under the classification of roads, construction of runways, taxiways and aprons are interpreted as being exempt from general building restrictions. But construction of buildings on airports is prohibited during the emergency housing period.

N-S Safety is Promoted By New CAR Part 42

CAB's new Part 42 of the CAR, which goes into effect Aug. 1, indicates the increasing attention the government is giving to safety in non-scheduled operations. Meantime, officials state that the new technical requirements represent but a modest beginning, and they don't believe any operator will be put out of business. However, an economic policy is in the making, with CAB considering submission of regular written reports to form a basis for overall changes in regulations.

Earlier, about 100 new non-scheduled airline operators met in N Y C and demanded regulation by CAA and CAB. Prewar N-S operators, then mostly of the 1620s generation, had previously opposed regulation of any kind.

N-S safety is promoted by new Part 42 requirements for An Air Carrier Operating Certificate, definite minimum of instruments and equipment, higher pilot qualifications and higher weather minimums, pilot flight time limitations, minimum fuel requirements, flight record filing, and keeping a check-off list in the cockpit describing takeoff procedure.

Pogue Bid to PICAO

Word came that the resignation of L. Welch Pogue as CAB chairman had been officially accepted by Pres Truman who then requested that he serve as delegate to PICAO's first annual assembly at Montreal running from May into June. Previously Mr Pogue had agreed to continue as CAB head until this month, when new chairman was to take over.

Succeeding to the post is James M. Landis, who has been associated with Harvard U as dean of Law School.

AAF Engineering Center Gets a Wary Eye

AAF proposal to set up a huge air engineering development center at an initial cost of $300,000,000 is being viewed cautiously by the industry.

Maj Gen Curtis E LeMay, deputy chief of staff for research and development, stated that the AAF could no longer depend upon small contracts to companies for development of air weapons and he proposed that the government furnish facilities to do the work.

The AAF's program would encompass even such advanced projects as development of space vehicles, bases, and space survival equipment; utilization of nuclear energy for propulsion, harnessing of light rays for destructive purposes, etc.

The center would be available to all government and civilian agencies engaged in aircraft design and production. At this writing NACA whose field is basic research and not application, had not yet commented on the proposal.

Energy is Bikini Prime Point

When the atomic bombs are unleashed at Bikini Atoll main scientific interest will not be what the blasts do to the targets, but rather the efficiency with which the A-bomb charges are converted into energy. The tests have been widely confused as being designed primarily to find out the effects of the new weapon on navies. However, as we go to press officials declare that the primary interest of the technical directors of the tests will be in the supersolar heat

(Turn to col. 1, page 112)

BELL'S NEW FIVE PLACE COPTER

Company's latest design, now being tested at Buffalo, is Model 42 five seater, slated to have a top speed of 125 mph and cruising speed of about 100 mph with a 450-hp engine. Range is estimated at 300 m. end endurance as 3 hr. Craft has a gross weight of 4,891 lb and normal useful load of 1,445 lb. Two blade rotor system is fitted with Bell's patented automatic gyro stabilizing bar.

* COMING UP *

June 12-25: International Air Show, DeHavilland Airport, Toronto (sponsored by National Aeronautical Association of Canada). NAAC Third National Air Conference will be held concurrently (June 14-15).

June 13-14: IAS Light Aircraft Meeting, Rackham Educational Memorial, Detroit.

June 13-15: First Postwar Annual New England Invitational Tour, sponsored by New England Aviation Trades Assn., Metropolitan Airport, Norwood, Mass.

June 15-16: First Annual Southeastern Air Show & Exposition, Municipal Airport, Craig Field, Jacksonville, Fla.

June 24-28: American Institute of Electrical Engineers 1946 Summer Convention, Statler Hotel, Detroit.

June 25-26: AIMA officers, directors and committee chairmen open meeting, Hotel Traymore, Atlantic City, N. J.

July 17-18: NAA national convention, Omaha.

July 18-19: IAS national annual summer meeting, Hotel Hollywood-Roosevelt, Los Angeles.

July 18-21: World's Fair of Aviation, Omaha.

July 26-27: NAA Joint Private Flying Conference, Milwaukee.

July 29-30: NAA Joint Air Youth Training Conference, Milwaukee.

Aug. 1-2: The National Flying Farmers Assn. First Annual convention & Oklahoma Flying Farmers Conference, Oklahoma A & M College, Stillwater, Okla.

Aug. 13-16: IAS Annual Summer Meeting, Los Angeles.

Aug. 22-28: First World Congress on Air Age Education, International House, New York City.

Aug. 22-24: SAE National West Coast Transportation & Maintenance Meeting, New Washington Hotel, Seattle.

Aug. 30-Sept. 7: First postwar Canadian air show, sponsored by NAA of Canada, DeHavilland Airport, Toronto.

Aug. 31-Sept. 2: National Air Races, Cleveland.

Sept. 4-12: Air Fair sponsored by Aviation Council of Metropolitan St. Louis, Inc.

Oct. 3-5: SAE National Aeronautic Meeting & Aircraft Engineering Display, Biltmore Hotel, Los Angeles.

Oct. 14-17: National Aviation Clinic, Oklahoma City.

Oct. 16-17: SAE National Transportation & Maintenance Meeting, Hotel Knickerbocker, Chicago.

Oct. 23-25: Second Annual Arizona Aviation Conference, Phoenix.

Oct. 24: IAS Air Transport Meeting, Statler Hotel, Washington, D. C.

Nov. 7-8: SAE National Fuels & Lubricants Meeting, Mayo Hotel, Tulsa.

Dec. 2-6: SAE National Air Transport Engineering Meeting, Edgewater Beach Hotel, Chicago.

Dec. 17: IAS Wright Brothers Lecture, N. Y. C.

NACA REVIVES OPEN HOUSE

Gathered here in Langley Field Memorial Aero Lab are nearly 200 of nation's topflight aviation engineers, officials and observers—guests of NACA during recent 15th annual tour of famed research center's facilities. First such inspection permitted since 1939 particularly geared to work being done in fields of supersonic flight. NACA technicians predicted that 750 mph plus craft would be flying sometime this year.

the bomb develops its unearthly pressures and the weird nuclear effects. Secondary interest will be in the damage inflicted on the steel fighting ships. (Also see feature, "Crossroads Critique," page 38.)

Service Merger Still Halted

Even though bill to merge Army, Navy and Air Forces under a single Department of Common Defense has been favorably reported by Senate Military Affairs Committee, a bitter back-stage opposition may now prevent action by current 79th Congress. Pres. Truman's order to Navy to stop its obstructive tactics cannot be wholly effective.

A compromise bill, to preserve independence of War and Navy Departments by creating a new Department of Air has been offered. Navy is expected to win some sort of compromise in the end.

Air Policy Bill Hits Hurdle

Sen. Hugh Mitchell's bill for creation of a National Air Policy Board to maintain peacetime air power is now threatened by a jurisdictional fight between Senate Commerce Committees. The bill itself is not controversial, since it merely commits the government to make a study. Some observers declare the $15 000 and three months time asked by Mitchell are insufficient.

Most Surplus Craft Sold

Bulk of war surplus airplanes salable for civilian use have been disposed of. Public opinion strongly opposed scrapping expensive combat equipment but this reaction is now easing off and thousands of craft massed at Albuquerque, N. M., Clinton, Okla., Kingman, Ariz., Ontario, Cal., and Walnut Ridge, Ark., will be broken down. Planes at each field would be sold in one lot to one purchaser, who could represent a cooperative. They would yield 210 000 000 lb of aluminum. Maintenance of the dead airplanes is costing War Assets Administration too much, officials said.

Three hundred surplus Fairchild PT-23s were sold recently for $500 to $1,275 each, more than 500 remain. WAA says Douglas C54-As are de-allocated and may be bought at $75,000 each, same for Convair PBY-5As $28 000 each. Beech AT-11s, now de-allocated, can be bought at storage depots for $17,500 to $25 000 each.

★ SPOT CHECKING ★

Three K-type airships have been purchased by Douglas Leigh Sky Advertising Corp., which plans to fit them with electric light signs of running letter type, stated to be visible at least a mi from 1,500 ft. First contract is with MGM for advertising concern's motion pictures.

Twelve awards, totaling $6,000, are being offered to those engaged in design, manufacture, or construction of any type of aircraft and mechanical or structural parts thereof by Lincoln Arc Welding Foundation. Called "Design For Progress" program, contest promotes study and preparation of papers on design construction application and use of arc welding. Further details on competition, which closes June 1, 1947, can be had from Secretary, James F. Lincoln, Arc Welding Foundation, Cleveland 1, Ohio.

AAF initiated tests at Muroc Lake to determine flight potentialities of Messerschmitt Me 163B rocket propelled fighter. Program covers three phases: gliding, powered flight and powered takeoff. A Boeing B-29 is to tow craft to desired heights for flight tests. Rate of climb up to 40,000 ft. will also be investigated.

CAA has a new ground instructor rating for certification of Link trainer operators. Applicants must pass a written examination. All CAA certificated schools offering instrument flying training must give Link instruction.

NAA announced sanction of National Air Races planned at Cleveland over Labor Day weekend, Aug. 30 to Sept. 2. Agreement was signed by William R. Enyart, NAA pres., and Frederick Crawford, pres. of Races and of Thompson Products. First N.A.R. since '39 will feature Thompson Trophy speed race, Bendix Trophy cross country derby and other special events. Benjamin Franklin is mgr.

Just revealed is fact that a Boeing B-17 towed a Bell P-39 fighter 1,040 mi non-stop on Sept. 1, 1942, a record still standing. Experiment proved feasibility of towing tactical aircraft.

Deadline for annual inspection of aircraft has been set at July 1, 1946. Planes not inspected within 12 mo. preceding this date will be considered unairworthy and will be grounded. Flying aircraft after this date without an inspection will subject owners or operators to penalties. Check must be made by a CAA inspector following required periodic 100-hr inspection by a certified A & E mechanic.

A study of U. S. education system, and its relation to military and commercial aviation needs has been started by Air Power League, and this will be followed by grant of a series of scholarships. Initial survey expected to take from 8 to 10 mo., will be directed by C. F. Kettering, v-p and director of research for GM.

Navy version of Lockheed Constitution is expected to be completed this summer. Military model is to be fitted with four P&W R-4360 Wasp Majors delivering 3,000 hp each, giving craft an estimated 300 mph-plus top speed. Wing span is to be 189 ft. and length 156 ft., with gross weight planned of about 92 tons. Plane will be capable of transporting 172 men in its twin decks. Commercial version is to carry between 92-180 passengers with luxurious accommodations.

Electrically heated rubber facings for preventing ice formation on intake cowls of jet planes are now being produced by B. F. Goodrich. Company states facings also serve as effective anti-abrasion shoes.

A nationwide contest to encourage safe flying by students is underway, sponsored by Piper and some 1,000 company dealers. A specially designed Piper Cub trophy will be presented by each dealer to pilot on his field who, in six months, flies greatest number of hours without any kind of accident.

A novel method of steering an aircraft carrier was developed by Midway C.O. Two rows of Vought F4U-4 Corsair fighters, facing each other, are lashed down along forward flight deck. Then, by turning over planes' engines at full gun simultaneously in either row, carrier's bow can be swung in desired direction, thus enabling ship to turn in a comparatively short radius.

N.Y.-Washington record was clipped by a Lockheed P-80A, which made 220 mi hop in 20 min. 15 sec.

Erratum: In our Nov. 1945 Aviation (Abroad page) Keith and Ross Smith were flyers credited for 1919 England-Australia flight in a Lancastrian. Actually, Ross Smith died some years ago, hence mentioning him in connection with this flight was incorrect.

During recent meeting of N. Y. State Aviation Council at Westchester County, their talks were given on major airline and feederline topics. Ralph S. Damon, AA pres., urged opposition to proposed state regulations governing major carriers, stating Federal government should maintain reins. C. S. Robinson, regional airline operator, spoke of need for small lines to get off beaten track and service more communities. Following meeting, new VHF instrument landing equipment for personal flyers developed by Federal Telecommunication Lab., the research unit of International Telephone & Telegraph, was demonstrated at nearby airport.

CAA marked 20th anniversary of federal regulation and promotion of civil aviation. Pres. Coolidge signed Air Commerce Act on May 20, 1926, vesting in Aeronautics Branch, Commerce Department, first specific governmental responsibility for aviation. That year a traveler could cover 8,404 air route miles. By end of 1946, routes of U. S. airlines will extend approximately 150 000 mi. In 20 yr., certificated pilots increased from 1,572 to some 340 000.

★ PLANES AT WORK ★

Nearly 5000 lb of top grade Douglas fir caulking was flown from Portland, Ore., to Galveston, Tex., aboard a National Skyway Freight Co. converted Douglas C-47. Taking only a day, flight made it possible to accomplish delivery of 3,500 board-ft in time for use in an auction.

An airborne service now designed to implement Audio Devices' new program of accelerated customer contact and technical educational service was inaugurated at La Guardia Field, N. Y. Using a specially equipped Waco cabin plane, firm plans to send a technician and sales or service material to all parts of country, as needed.

Cargo of new S-40 Hallicrafters radio receivers was rushed to N. Y. dealers from Chicago aboard an AA Douglas DC-4 in 3 hr 42 min in response to heavy demand.

Emergency shipment of 18 gasoline drive generator units was flown from N. Y. C. to Chicago in 4 hr during recent coal strike in order to provide electric facilities in schools, hospitals and other public institutions in that

area. Carrier was Air Cargo Transport.

In order to keep mill schedules going to meet prior commitments for Fall consumer trade, six bales of raw silk valued at $8,500 were flown across country in 10 hr via TWA Lockheed Constellation after arrival from China. Sea shipment had been delayed by typhoons and flight helped make up for lost time.

Largest combined air shipment of farm machinery was started by cargo planes of four airlines with planes rolling right up to doors of former Willow Run bomber plant and loading up with Graham-Paige Rototillers for delivery to all parts of country. In first haul, ten Douglas DC-3s took off in succession to carry combined load of 480 machines to ten widely separated points. Airlines participating are EAL, TWA, Slick Airways and U S Airfreight Co.

Largest single air shipment of flowers was made from San Francisco to eastern markets in time for Easter. TWA and Slick Airways split 380,000-flower load among three Curtiss C-46s and five Douglas DC-3s.

Tons of fresh foods and perishables were flown into Alaska by Douglas DC-3s during recent longshoremen's strike.

Fresh fish and seafood were flown by seven airlines for test sales in A & P Supermarkets during Lent. New iceless insulated paper containers were utilized, weighing only one tenth of their contents. Flights were made in cooperation with Wayne University's air cargo research program.

All-America Football Conference signed 5 year's contract with UAL to provide air transportation of member teams for regular games, training trips and exhibition contests. Charter agreement amounts to about $250,000.

A new "high" in aerial forest fire observing was revealed recently by press. A New Jersey flying fire warden reported that he actually spotted an alleged firebug at work, notified forest fires hq, and had suspect intercepted.

THERMAL RIDERS SET ENDURANCE RECORD

Paul A. Schweizer (left), gen. mgr. of Schweizer Aircraft Co., glider maker, congratulates Richard Powell and Franklin E. Hurtt after they stayed aloft 10 hr 9 min over Harris Hill, Elmira, N Y. Previous mark of 9 hr 17 min was made by Mr Hurtt and Mr Schweizer. In making the new endurance record subzero temperatures and icing conditions were encountered and landing was made in a snowstorm. Craft is SGU 2-22, all metal structure utility two-placer which company plans to put into production soon.

Regular weekly overnight air shipment of women's clothing from N Y C to Los Angeles was inaugurated by Sears Roebuck. Carrier is National Skyway Freight, and each flight will consist of about 5,000 units.

Cab Calloway purchased a surplus Douglas C-47 and plans to use craft for touring his band. Plane is to be soundproofed to permit rehearsing en route.

★ CALLING NAMES ★

James E. Boyce has been appointed Lockheed's eastern regional mgr.

James P. Cunningham has been named Luscombe v-p in charge of production.

Douglas appointments: **Fred W. Herman** has been made plant mgr Long Beach, to succeed **A. C. Wallen,** who was made production mgr at Santa Monica. **Charles W. Faull** has been named Dayton, Ohio rep, succeeding **C. W. Hamilton,** who has been assigned as sales development mgr at Santa Monica.

Thomas Wolfe, formerly v-p of WAL, has joined United-Rexall Drug as asst. to pres.

Ellis Emmons Reed has been made pub rel mgr for Air France in North America.

Cl R. Smith has been elected pres of American Overseas Airlines, succeeding **Sumner Sewall,** now with War Dept. on undisclosed assignment.

UAL appointments: **W. A. Patterson** was re-elected pres. **W. R. Thigpen** has been named special asst to pres with hq in Seattle. **M. P. Bickley** has been appointed mgr cargo sales with hq in Chicago. **Gordon D. Logan** has become district traffic & sales mgr at Phila.

Col Franklin C. Wells has been appointed gen sales mgr for G M Giannini, Pasadena.

Gen Carl Spaatz has been appointed a member of NACA succeeding Gen Arnold on Committee.

Donald E. Wood has been appointed exec asst to v-p. and gen. mgr of TACA Airways with hq in Miami.

K R Ferguson has been elected member of board of directors of Aeronautical Radio.

PCA elections: **C. Bedell Monro,** pres.; **James H. Carmichael,** exec v-p; **J. J. O'Donovan, Luther Harris** and **Robert J. Wilson,** v-p; **R. G. Lochiel,** v-p. & treas. **Robert H. Ames** has been named asst. to dir pub rel.

Joseph A. Young has been appointed operations mgr for C&S.

Wesley R. Bunker has been named v-p for American Air Express.

Franklin D. Walker has joined Fairchild Engine & Airplane's pub rel staff as editor of "The Pegasus".

Col Weldon E. (Dusty) Rhoades has been appointed director of Air Navigation-Traffic Control group of ATA.

Nicholas Craig has been appointed sales mgr for Panagra with hq in N Y.

Col Robert L. Copsey has been named state aviation director for New Jersey.

Holden A. Evans, Jr., has been appointed secy of New York City Airport Authority.

Ralph G. Lockwood has been named Chief of Maintenance & Salvage Office of Aircraft Disposal, WAA.

Colonial Airlines elections: **Sigmund Janas,** pres.; **Edward S. Ridley,** v-p; **Branch T. Dykes,** v-p in charge of traffic. **K. Hamilton,** secy.

CAA appointments: **Harry G. Tarrington** named chief Div of International Activities. **Howard W. Sinclair,** appointed asst administrator for aviation training.

L. C. Doolittle has been named sales mgr of aviation div of Weatherhead Co.

Milton L. Fitch has been elected pres. of Worcester, Mass Chapter NAA.

Croil Hunter, pres. & gen. mgr of NWA, has been appointed national chairman of Hong Memorial Foundation.

Rudolph F. Lemke has been appointed service mgr at Pacific Airmotive's Oakland hq.

United Aircraft elections: **William P. Gwinn,** gen mgr of Pratt & Whitney has been made v-p; **Rex B. Beisel,** gen mgr of Chance Vought div named v-p.; **Lauren D. Lyman,** in charge of pub rel., has been made v-p.

Zeo D. Donley has been named adv mgr at Pacific Airmotive, with hq at Glendale, Cal.

Royal Jordan was named European region traffic mgr of TWA.

Mrs Ariana Davis, woman flyer, has been appointed chairman of national Wing Scout Advisory Committee.

Jack Frye has been re-elected pres of TWA for thirteenth consecutive yr.

* CAA TYPE APPROVALS *

Aircraft: Cessna 120 and 140 ATC 768. Airworthiness Certificate: Douglas UC 67 and B-23 2-76.

Engines: Franklin 6V4-178-B31 ATC 244. Lycoming 0-435-11 ATC 228. P&W Twin Wasp D5 ATC 238.

Propellers: Hartzell 44K11003 and 8516E, ATC 837. Sensenich 88KF and 73KR ATC 838. U S Propellers 43K10107 and 12AC ATC 839. Stearman SQ-280, ATC 840. Curtiss C-228-E ATC 73. Hamilton Standard 22D ATC 736.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

There's one wide field in aviation that isn't regulated. It's parachute jumping. You just buy or borrow a chute, any kind, and jump—if you want to. Schools are starting; it's a wonderful sport. But hurry—because CAA does have a rule against throwing "objects" from planes over populous areas, and now lawyers are debating whether a person is an object, or something else. There'll be a law.

To the Powers-That-Be goes The Stubblefield Award this month. Selig Altschul, now CAB analyst, did an essential writing job on one of the U S Strategic Bombing Survey reports—and then had to pay the Public Printer 50¢ to get a copy of it.

Mystery: Post Office representatives now sit in CAB hearings on every application for airmail air routes. Why they haven't been sitting in there all these past years nobody can explain.

Airport congestion is an increasingly serious threat to growth of all civil aviation, and the new federal aid, along with surplus fields, won't entirely dispel it. Search for means to eliminate long ground runs—takeoff assist, landing arrest, and the like—is intensifying in order to permit operations in less space.

Plan Huge Supersonic Research Center; Air-Status Vigil in New Procurement Bill

. . . Free AA to buy CV 240s . . . Project new artillery plane . . . Re CV, UAC Terminations . . . AIA, CAA tackle problems . . . Engine output reported . . . B 29 in cosmic ray check.

A supersonic research center, to cover 100 sq mi with wind tunnels to test full-size aircraft at high Mach numbers and reproducing stratospheric conditions is planned for location in the West preferably near the Grand Coulee power plants on the Columbia River State of Washington.

Army Air Forces initiated the half billion dollar project in cooperation with the NACA. Undoubtedly the Navy's air arm, the aircraft industry and the National Science Foundation to be established by Congress will participate. Debate will involve the proposed Army-Navy merger and final authorization is not expected for a year or two.

It is estimated the fans, to develop wind tunnel air currents exceeding 1 000 mph., will require as much as 1 000 000 hp., a large portion of the total generated at Grand Coulee. NACA's engineers have been in the Big Bend region recently making preliminary surveys of sites.

Air Status Vigil Features New Procurement Bill

A bill revising the aircraft procurement system is nearing completion in Congress. Measure requires the Secretaries of War and Navy to make frequent reports on their departments' aviation activities, which will be closely watched by Congress. Each Secretary would have broad powers over experimental work in the public interest.

The bill stirs consideration on the question whether Ordnance or the air arms should have charge of guided missile development. Should "uninhabited" missiles largely replace airplanes for future bomb assaults—and then be handled by ground forces—the status of military aviation, as such, would be affected.

Final form of the aircraft procurement bill may be importantly changed if a separate Air Force results from the proposed Army-Navy merger.

Free AA to Buy CV-240s

CAB has withdrawn an order which would have prevented American Airlines from buying $18 000 000 worth of airplanes from Consolidated Vultee. After the Board had contended that both companies were controlled by The Aviation Corp., and that therefore the purchase was illegal, the order was vacated when Avco reduced its holdings to less than 4% of voting stock outstanding. AA was freed to consummate purchase from Consolidated Vultee of 100 Model 240 transport planes.

Project New Artillery Plane

Renewing its interest in so-called "safety" planes for artillery-fire observation and for other liaison work, Army Artillery through the Air Forces, which procures its planes, has received proposals on a new design, from Consolidated, Boeing, Piper, Bellanca, and Ludington Griswold.

Coming in response to a general invitation these proposals are being examined at Wright Field, and awards are expected soon. CAA and AIA cooperated in suggestions to Air Forces that military liaison and civilian lightplanes have common design features.

Re CV, UAC Terminations

In termination settlements Air Forces has agreed to pay Consolidated Vultee $83 000 000 on a contract which called for delivery of 1 213 B-32 bombers cancelled after V-E Day. AAF had paid $75 000 000 for 114 delivered planes.

United Aircraft has accepted $52 000 000 on terminated Army and Navy contracts totaling $723 000 000. Additional $30 000 000 was agreed on for future claims of subcontractors. All of the contracts were Navy, some delegated by the Army. In March, BuAer had outstanding 1 437 terminations totaling $2.5 billion.

AIA, CAA Tackle Problems

First joint engineering conference of the Aircraft Industries Assn and CAA to deal solely with personal aircraft was recently held in Washington. Problems in certification, design requirements, flight testing, and the like, were discussed.

Specific subjects: Data needed to prove eligibility for certificate; delays in approval of design changes, manufacturers' designated inspectors and engineering representatives; delays in export certificates, waiver of tests flying before export, what countries we have reciprocal agreements with, CAR 17 and the cost of instruments, international airworthiness agreements, and delays in transfer of title to purchaser. Conclusions had not been reached at this writing.

Engine Output Reported

AIA announced that 256-915 military aircraft engines were produced in 1944 and 109 895 in 1945. For Jan 1946 total was 121, Feb., 140, and Mar., 135. In addition, 1,203 military jet engines were produced in 1945.

Civil aircraft production in 1945 was 2 047 units. Totals of military aircraft engine production in each of six years beginning 1940 are given by AIA. Monthly totals 1945 are reported for both piston and jet engines with breakdown by hp and thrust respectively.

Labor turnover in the aircraft industry in 1945 is stated in percentages, varying from 4.8 to 51.1, by months.

B-29 in Cosmic Ray Check

A series of experiments is being conducted by Guided Missiles Branch of AAF Research & Engineering Div to determine the effect of cosmic rays on various chemicals and metals. A Boeing B-29 carries specimens and instruments at altitudes of 25 000 and 35 000 ft. National Geographic Society is participating to determine cosmic rays affecting the earth.

* INDUSTRY MEMOS *

Republic booked order [illegible] for AA at cost of [illegible] each. [illegible] raised its [illegible] order to 18, at $1,1[illegible] each.

Grumman expects to turn out [illegible] Mallard amphibians this year, [illegible] about [illegible] each. [illegible] market for new craft is [illegible] units. Company [illegible] stopped taking orders on [illegible]. As for production on latter item, goal has been raised to 10 000 units.

Douglas is readying a new close [illegible] control unit for cargo planes designed to maintain temperature stability through out long flights and [illegible] losses in shipment of perishables.

All new Ercoupes are being fitted with [illegible] design [illegible] based on same [illegible] action principles as former Ercoupe [illegible] following are features: [illegible] aluminum [illegible] brake [illegible] disk brakes and wheels, [illegible] wheels and tires, and [illegible] steel oleo structure.

Boeing went into quantity production of its new Model 417 feederliner. Powered by two [illegible] hp. Wright Cyclones, it is designed to accommodate 20-24 passengers. Craft to be of high-wing [illegible], will utilize retractable tricycle landing gear. Company retained Walter Dorwin Teague organization to assist with interior styling of Stratocruiser, for which company has $[illegible] under backlog.

Piper started production of new PA-12 Super Cruiser (formerly designated J-5) with backlog on this type estimated as [illegible] units.

C-W Propeller Div. is busy fulfilling orders for electrically con-

AEROMATIC'S NEW MULTI BLADER

Towering over Paul F. Hekelhel (right), chief engineer, and Sid Feban, manager, is Aeromatic's giant new 8-blade contra-rotating propeller developed for 2 500 hp aircraft engines. Especially notable: Prop's design dispenses with need for conventional hydraulic or electric pitch changing, this operation being accomplished by natural physical forces during rotation. Blades are of high-strength plastic-bonded plywood covered with hard Aeroloid plastic. Mr. Feban holds small 200-hp Aeromatic prop for light planes. It's designed on same pitch change principle. (J. H. Schaefer & Son photo)

trolled reversible pitch props for AA, AOA, NWA, PAA, TWA, Air France, KNILM and Swedish Airlines.

Commonwealth expects to achieve production of ten Skyrangers daily this month and ten Trimmer amphibians daily by Sept. Output of latter is slated to reach 25 daily by year-end.

Hamilton Standard is now in production of small two-blade Hydromatic props in 450 hp range. Installation tested on Beech 18 is said to have given craft 100-fpm increase in climb and raised absolute ceiling by 2,400 ft.

Permoflux Corp of Chicago states it has constructed truly echo-less chambers for testing efficiency of radio speakers. Designed to absorb sound waves, installation consists of two rooms, one suspended within other and set on damping pads.

With Departments of State, Post Office and Commerce reported studying feasibility of new efforts to establish lighter-than-air transocean services, Goodyear Tire & Rubber Co announced plans to build a fleet of super dirigibles to carry passengers and cargo which they said could be put into operation within 5 yr.

Total of 6,278 new aircraft engines ranging from 65 to 1,050 hp, declared surplus by Navy, were placed on sale to first comers by War Assets Adm. Stored at several Navy installations, plants include Continental, Lycoming, Warner, Jacobs, Ranger, Wright and Pratt & Whitney, in lots of a few to several hundred each.

★ FOR THE RECORD ★

Pacific Aircraft Sales Co has reactivated Southern Cal hq in Pacific Airmotive Corp hangar at Lockheed Air Terminal.

Faircraft Corp, Danville, N Y, is new aircraft maker formed by ex-C W and Bell engineers, who plan to build a two place 100-hp personal plane to sell for $3,000.

Wright Aero contracted to sell to Aero Holding Co of N J its Plants 1 and 2 in Paterson, N J.

Airborne Instruments Lab, Mineola, L I, is new concern formed by electronics engineers from Harvard, MIT and Columbia, to develop new products and procedures for airlines and services. No manufacturing is contemplated.

Gulfore is new organization planning to merchandise products adaptable to air transportation through use of commercial airlines and company's own fleet of cargo planes. Business offices are in Cravens Dargon Bldg, 1205 Holcolm St., Houston, Tex.

Piasecki Helicopter Corp. is new name for former P V Engineering Forum Inc. Company will continue helicopter activities.

Lockheed established a supply and overhaul base at Linden Airport, Linden, N J, to supply spares and facilities for overhaul and repair of Constellations. Walter McGinty is in charge.

Douglas moved El Segundo Engineering Div back to El Segundo production plant adjoining Los Angeles Airport. Div's former quarters are to be used by CAA's Sixth Region hq.

Eclipse Pioneer Div of Bendix appointed Aviation, Ltd., 3483 Park Ave., Montreal, as Canadian sales and service rep for div.

Colgate Aircraft Corp, Amityville, L I, N Y, purchased for occupancy former Grumman building at 14th St., south of West Hoffman Ave., in Lindenhurst, L I, and plans to use space for augmenting present production.

Jones, Page & Gillies inaugurated nationwide service as aviation consultants with hq at 1227 19th St, Washington 6, D C.

Wings Club moved its quarters to Hotel Biltmore, N Y C.

NATA opened a Washington office at 1400 Connecticut Ave for liaison with government agencies for fixed base operators.

Kellett planning to expand operations to double wartime peak, has arranged to lease 400,000 sq ft. WAA owned airplane wire plant at North Wales, Pa.

Western Electric leased Fairchild plant at Burlington, N C, for 3 yr, with option to purchase, and plans to locate there operations now at Kearney, N J, and Baltimore, Md.

Atlantic Aviation, sales and service operator, began activities at Baltimore Municipal Airport.

Timken Roller Bearing is testing a new method for achieving new perfection in metallurgy and geometry of bearing making. Employed is a pilot plant at Zoarville, Ohio.

New Accounts: Douglas appointed J Walter Thompson agency to handle domestic advertising and Dorland International-Pettingell & Fenton to handle foreign account. East Coast Airlines appointed Moore & Hamm as its agency. BOAC named Cecil & Presbrey to promote new program.

MASS SEND-OFF BY CESSNA

To supplement firm's flyaway schedule, Cessna is delivering a portion of its Model 140 production via trailer trucks. Careful study showed six planes can be stowed in vehicle depicted, resulting in considerable saving in transportation charges.

H D INGALLS . . . *veteran maintenance chief American Airlines pre-war, and for ATC at Northeast Airlines during the war . . . now General Manager of the new Bluegrass Airlines, is making an extraordinary operating record with his "progressive maintenance."*

Burning daylight in Kentucky!

With only two converted Cessna transports powered by wartime Jacobs engines . . . Bluegrass Airlines gives Kentucky statewide service, links seven cities with regularly scheduled week-day flights, logs 960 miles daily and 5760 miles per week! And will shortly add Sunday operation with the same equipment!

How do they do it?

"Progressive maintenance" . . . the system developed by Bluegrass' headman H. D. Ingalls while in charge of ATC maintenance on Northeast lines during the war. Bluegrass' trim planes on alternate days end their trips at Bowling Green, the company's base, where a veteran AAF crew checks and overhauls some portion of plane and equipment each night on a rotating schedule. The ships are kept in service without the loss of flying time.

The Jacobs R755-9 engines fit into this flight operation program like web feet on a duck . . . maintain schedules at only 1850 rpm, 58% capacity . . . use as little as 14 gallons of fuel and only 1 quart of oil per hour.

The compact rear case and unique accessory drive unit permit quick, easy inspection of tubing, wiring, control linkages, and facilitate engine change, reduce line maintenance details. For dependable, low cost performance with minimum maintenance, Ingalls rates the R755-9 as one of the most satisfactory engines he has ever known . . . believes that his current 650-hour period between majors could be extended without undue wear or safety infringement.

Today the new R-755A is an even better Jacobs . . . because of intensive research, improved metals, quantity production experience . . . weighs no more, but delivers 33% more power — 300 hp at 2200 rpm — is more sparing of fuel and oil . . . is the most efficient non-supercharged radial in its power class available today . . . Ready for delivery now, too! Inquiries invited . . . Jacobs Aircraft Engine Company, Division of Republic Industries, Inc.

JACOBS • **Pottstown, Pa.**

Division of Republic Industries, Inc.

Senate Body Scouts Bermuda Pact Legality; State Three Points for Accord With Russia

. . . Balkan air link sought . . . Push for transport agency . . . Fact-finders vs. strike . . . Mergers and expansions.

In a 14-to-1 vote Senate Interstate Commerce Committee challenged legality of the Bermuda agreement between the U. S., Britain, and France. This pact was undertaken to arrange schedules and rates between the three countries and to open military bases in the Atlantic for commercial aviation.

Committee move means that the Bermuda agreement will not be effective until the controversy is settled. CAB is not subject to criticism, because it merely assisted the State Department in negotiations. The latter submitted the final document, as an Executive action, to Senate Interstate Commerce Committee for comment.

If Congress decides the agreement is a treaty, it will have to be confirmed by a two-thirds vote of the Senate.

State Three Primary Points For Accord With Russia

During meetings with Russian officials this summer, the U. S. State Department will (1) attempt to obtain rights to terminals in Leningrad and Moscow, (2) will ask benefits of the "Fifth Freedom," and (3) will propose that there be no limitation on schedules.

Moves comprise second step following Soviet agreement to discuss exchange of air services between U. S. S. R. and U. S. (page 125 May AVIATION). Considerations in the proposed billion-dollar loan to Russia are seen involved.

The United States-Russia agreement would be fashioned after the Anglo-American-French Pact of Bermuda. American Overseas Airlines has been assigned the proposed route to Moscow.

Balkan Air Link Sought

The U. S. hopes to extend airlines into the Balkans and is opposing Russian plans to set up monopoly airlines there. This subject will come up in discussion of the proposed exchange of services between the Soviet and U. S.

Russia, meanwhile, is regarded as certain to oppose establishment by TWA of a cooperative airline system in Italy. Italian government approval also seems doubtful because of Russian and British opposition. British object mainly because BOAC is frozen out.

Push for Transport Agency

Increasingly exerted is pressure by surface transportation for "integration" of all transportation under one federal agency, as House Interstate Commerce Committee prepares to investigate the economic inter-relation between rail, water, highway, and air services.

Sea-Air Committee is demanding air auxiliaries for shipping. Air Transport Assn. sent a recommendation to the House Committee that air transport continue under independent ownership, and under separate regulation.

The statement, by Emory B. Land, ATA pres., also asked that further multiple state taxation be halted, and that interstate airlines be subject only to federal authority.

Fact-Finders vs. Strike

After months of controversy between the Air Line Pilots Assn. and the airline wage negotiating committee over pay increase for flying 4-engine equipment, ALPA threatened to strike TWA's 25,270-mi. domestic and foreign route system. Efforts toward mediation and arbitration having failed the National (Railway) Mediation Board reported an interstate commerce emergency to the President.

Appointed was a fact-finding board, which must recommend terms of settlement within 30 days, after which both parties in the dispute must refrain from strike or lockout for 30 more days. The fact-finders recommendations will cover all 13 airlines operating or planning to operate, 4-engine planes.

Mergers and Expansions

PCA urged at hearings that CAB approve a merger with Northeast Airlines already approved by stockholders of both companies. PCA contends increase in resources and credit would permit complete development of traffic potential . . . Another step in airline expansion was application by UAL for extension from Omaha, Denver or Cheyenne into Los Angeles. United's passengers now must transfer to Western's planes for L. A. Previous applications have been denied . . . CAB examiners recommended that AA's application for approval of merger with Mid-Continent be denied, saying an "excessive" price had been offered by AA. . . . U. S. Circuit Court of Appeals, Washington, upheld CAB's award of Denver-Los Angeles route to Western in 1945. United had appealed from CAB's decision.

★ CROSS COUNTRY ★

If U.S. domestic airlines receive all new transports now on order, they will provide in 1946 a seat-miles capacity for surpassing the passenger-miles credited to Pullman travel in '41, according to a comparison developed by Alvin E. Adams & Assoc., aviation consultant company of Los Angeles. New equipment orders would give airlines a total of 1125 planes, if DC-3s now operated are counted in; however, many of latter will be retired. Adams' study analyzes 1946 business as 165% over that of '45.

EAL moved airline's Tampa, Fla., operations facilities and all flight activities from Peter O. Knight Field to Drew Field in that city . . . Company is issuing newly designed seasonal booklets advising patrons on temperatures expected at destinations and giving tips on types of clothing to bring.

Santa Fe Skyway, recently organized subsidiary of Atchison, Topeka & Santa Fe Railway Co., purchased seven surplus Douglas C-47s and spares to supplement railroad's freight service with air cargo transport.

PCA took delivery on Douglas C-54 plane which carried late Pres. Roosevelt and his staff to historic Big Four conference at Casablanca. Now re-named "Capitaliner Milwaukee," craft carries a bronze plaque in cabin commemorating the conference flight.

New airlines. Monarch Airlines, Stapleton Airfield, Denver 7, Colo., operating in Rocky Mountain region, has been certificated by CAB. Head is Ray Wilson . . . NATS Air Transportation Service is new non-scheduled airline operating from Oakland, Calif., Municipal Airport. Company, formed by ex-Naval Air Transport Service (NATS) pilots, received official permission to adopt name.

Grant of 3-yr. temporary certificates to feederline operators in Rocky Mountain and Fla. areas, followed by an examiner's favorable report on a feeder network in Tex. and Okla., is regarded by competent observers as start of nationwide short-line expansion. CAB and Post Office Dept. are increasingly favoring feeder expansion in response to public opinion. CAB seems to have no fixed policy in choosing new companies against extension of existing operations . . . P.O. Dept. has set up a nine-man research board to prepare data in support of applications for routes which P.O. thinks will improve mail service.

★ CANADIAN NOTES ★

By James Montagnes

New international scheduled air routes have been allocated by Canadian Air Transport Board. Colonial Airlines has been licensed to operate Montreal to N. Y. and Washington and Ottawa to N. Y. and Washington (but not between Ottawa and Montreal) . . . TCA has received its license covering Toronto-N. Y. service, now in operation. Toronto-Chicago service is to start in July and Toronto-Cleveland runs are to begin in August. Douglas DC-3 aircraft are to be used on all routes.

Canadian mining companies frequently operate their own planes. Latest additions are Sherritt Gordon Airtransport for Sherritt Gordon Mines in northern Manitoba, and Uscan Engineering Corp. for group of Yellowknife (Northwest Territories) mining companies. Used are DC-3, DH Fox Moth and two Noorduyn Norseman craft.

TCA Notes. Airline's first Canadian built Douglas DC-4 is expected to be ready by year-end. Meantime 24 converted C-47 transports are slated for use by late summer . . . Chain of radar stations is being installed on Montreal-Windsor (Detroit) route to aid pilots in telling distance from one or more selected ground stations . . . TCA surplus of $3?,77? for 1945 quadruples 1944 surplus of $?,?89 . . . Decentralized traffic offices have been established by airline at Montreal, Toronto and Vancouver.

IDLEWILD'S TEMPORARY HQ

Beyond PAA Lockheed Constellation, roaring across massive Idlewild Airport on recent inspection flight of terminal, is seen control tower topped administration building which is to be employed until more permanent structures can be erected. Plane did not land.

★ INTERNATIONAL BRIEFS ★

ENGLAND—Heath Row, now bearing new name London Airport, will soon be a base of operations for both Pan American and American Overseas. Trip it to town will be cut to 40 min. Time from Hurn has been 3 hr.

Fairey is developing a new type helicopter, named Gyrodyne, combining features of both rotor and autogiro. Gyrodyne is intended to provide new simplicity and safety.

Ministry of Civil Aviation is preparing a complete chain of direction finder stations in England to aid development of safe flying. Britain has been divided into six regional districts to simplify organizational setup.

British European Airways expanded its services with connections to Copenhagen, Oslo, and Athens via Marseilles and Rome.

BSAA is reported to have underbid PAA's mail rate for carriage from Argentina to England. If a said line is obtaining virtually all European airmail from Argentina.

A four cylinder opposed air cooled engine of 70 to 100 hp, depending upon bore, was introduced by Monaco Motor & Engineering Co. Cubic displacement is 182 cu in. for 70 hp. model and 218 cu in. for 100 hp. engine. Weighing around 200 lb., engines were developed to compete with low power American types.

BELGIUM—Recently reported interim air agreement (MAR AVIATION) was superseded by a final accord, providing use of Leopoldville in Congo by U. S. airliners, also landing rights at Brussels.

RUSSIA — Commercial airlines are planning a network of more than 100,000 mi. by 1950, for which 30 new airports and 10 intermediate fields will be built. All equipment and facilities are to be expanded and modernized.

HOLLAND—KLM was awarded landing rights at Miami and N. Y. G. Trans-Atlantic service opened May 31. Miami route has been in operation throughout war under emergency permits.

FRANCE—Numerous types of postwar aircraft were shown at air show near Paris recently. Most were prototypes though some have been produced for export. Presented were a small single-seater coating about $1,000 and a two-seater flying wing.

NORWAY—Latest entry in trans Atlantic race is DNL, official airline managed by Col. Bernt Balchen, who recently took delivery of company's first Douglas DC-4. DNL eventually is expected to join Sweden and Denmark for a combined Scandinavian service to N. Y.

EGYPT—Formation of a new Egyptian airline with BOAC holding 49% interest is considered another step in British plans for covering Europe with a network of British-controlled local companies. Such organizations have been formed in Eire, Greece and Egypt.

New French magazine, 'Decollage,' presents details on three-place Nord 1500, awarded Government Grand Prize for touring planes. Tricycle geared craft cruises at 180 mph., consumes 1 gal every 15 mi., and weighs 1,613 lb empty.

Latest four engined French plane is Languedoc 161, built at Toulouse. With 109 ft span, gross weight of 81,000 lb. and four 1,200 hp Gnome & Rhone engines, plane cruises at 220 mph., and it is stated it can carry 65 passengers 1,000 mi., or 7 tons of cargo 800 mi.

SPAIN—Iberia, Spanish airline, now operates seven Douglas DC-3's and three DC-4's on services between Spanish possessions and to Lisbon. Plans call for services to Buenos Aires, Geneva, London, and Paris, to be operated with DC-4's.

EIRE—New airline was formed to connect Ireland with Britain and Continent, with BOAC holding a 40% interest. A new Anglo Irish air agreement provides for specification of service frequencies and new company is expected to aid in control of Irish international airlines.

INDIA—Indian National Airways ordered six Vickers Viking 54 passenger airliners with which it plans to operate its proposed routes.

AUSTRALIA—Airline bill battle is continuing with ANA's request for permission to appeal to Privy Council against High Court decision, which held that bill was valid insofar as it permitted Government operation of its own air services.

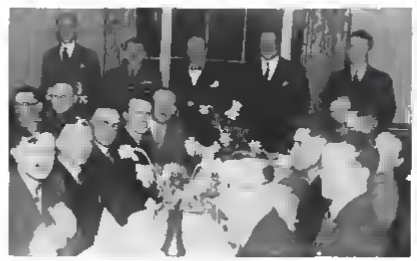
British technical missions will make rocket bomb tests in Australian South Eastern Desert. Headquarters have been set up at Ceduna.

Mascot airport at Sydney is being expanded at a cost of $30,000,000 to include an 8,000 ft. runway and three smaller runways. It is felt this expansion will be sufficient till 1955, when further construction is planned.

Australian Government has completed negotiations for purchase of BOAC's interest in Qantas making it entirely Australian, and also a government-controlled concern.

CHILE—Coincident with Air France's reopening of Paris-Santiago service, agreements were completed with Argentina and Brazil allowing reciprocal air services to and from Rio and Buenos Aires.

MEXICO—Panini's sale of 40% of its stock to New Haven interests fell through when Panini upped his price. A later attempted sale to CMA was not completed for similar reasons. Company is still looking for a buyer.



WHITTLE HONORED BY COLLEAGUES

Following resignation of Air Commodore Frank Whittle (second from left, standing) from board of Power Jets, Ltd., a farewell dinner was tendered him by original members of company's engineering staff. Upon decision of British government to convert firm into National Gas Turbine Establishment, Whittle left nonrun and most of technical engineers are following his lead. Squirted in back row (left to right) are J. C. S. Tinling, Power Jets founder; Whittle; W. E. P. Johnson, Power Jets executive; Michael Dannt, Gloster test pilot; and N. D. Williams, another Power Jets founder.

WORLDATA . . . . . By "VISTA"

With controversy in Washington and London over the TWA-Italy airline arrangement, there already are some indications that similar arguments will plague the TWA-Ethiopia contract. The Italian contract, signed last February, provides for 40% TWA participation in a new Italian airline, to operate domestic and international services. Talk of "secret" angles in the Bermuda decisions is discounted, it appears, rather that the British feel their particular spheres are being invaded.

There are further considerations, on the British side involving realization that American management of foreign airlines means American equipment, and that such contracts would eliminate for many years foreign air transport markets which Britain needs. In any case fruition of the Bermuda plans apparently will have to wait till the Italian crisis passes and may even be postponed until the Ethiopian plans of TWA are fully aired.

Parliament in London finally received the long-awaited airline nationalization bill. Organization of three national airline companies has already been reported. Bill, providing for government purchase of all British airports, calls for subsidies of $50 million each of the first two years, and $40 million per year for eight years until 1955. Capitalization maximums were set at $200 million for BOAC, $80 million for British European Airways, and $40,000,000 for British South American Airways. While charter companies supposedly are to be encouraged, wording of the present measure is such that virtually any chartered airplane flying between two airports served by one of the three government corporations becomes subject to scrutiny.

Airports can be acquired by purchase but outright confiscation of land is also mentioned in legislation. Latter feature together with provision that when existing airlines are taken over they will be reimbursed for actual property values only, is expected to cause considerable debate.

Recent British Commonwealth Air Conference in New Zealand dealt with formation of British Commonwealth Pacific Airlines to operate a route to America and Canada parallel to a Canadian company. Until this new line can get started, services would be operated temporarily by an existing airline, but so far no decision has been announced. ANA with its new Douglas DC-4s, is ready to run twice-weekly services but cannot operate without official sanction. In meantime, Australia is without direct connections across the Pacific, causing serious concern in Australian business circles. Main hold-up now appears to be submission to Washington of a reciprocal U. S.-Australian air agreement, without which neither PAA nor any Australian company can operate.

Curtiss-Wright has a backlog of $55,000,000 in unfilled orders but sustained a loss in first quarter operations according to Pres. Vaughan. Company is consolidating its 17 wartime plants into 2, where peacetime manufacture of engines, propellers and airframes will proceed.

Castrol of United Aircraft Products Inc., was won by officials of Metel Products Corp. at recent annual meeting. Following election, it was voted to split common stock on 2-for-1 basis. Five new directors were elected, the old management retaining four directors.

Lockheed plans "an aggressive entrance into private plane field as soon as certain basic problems have been solved." Pres. Gross reports. Unfilled orders are $198,739,000, of which $144,000,000 are military and $55,000,000 civil (transports).

Republic reports first quarter net income of $548,603 or 55c a share on sales of $13,609,-086. Pres. Alfred Marchev stated that unfilled orders were $66,950,000 on Mar. 1, against $45,270,000 at end of '45. In addition Aircooled Motors, a subsidiary, had orders of $5,028,000, of which $1,030,000 represented orders other than Republic's.

U. S. Air Lines, Inc., of St. Petersburg, Fla., has registered with SEC 600,000 shares of common stock, which will be offered to public at $3.25 a share. Proceeds will be used to pay up a bank loan and finance additional company equipment.

Beech reports net loss of $164,-647 for six months ended Mar. 31. Sales were $9,348,000 for period. Since January, company has shown a profit on operations.

Bendix Aviation Corp. reports net loss of $1,415,720 for three months ended Dec. 31, 1945. Deficit before a tax carryback refund of $3,430,000 was $4,845,720.

Dividends: Bellanca directors have decided to forgo declaration of a common dividend at this time. Last December a 12½c. dividend was declared, and directors stated their intention to pay dividends quarterly. . . . Continental Motors paid a 15c. dividend last month, first declared this year. Four 20c. dividends were declared in 1945. . . . Aeronca paid a 13¾c. dividend last month, while Consolidated Vultee paid 50c a share and United Air Lines announced a 50c. dividend to be paid on July 1.

Northrop anticipates "satisfactory earnings" after current fiscal year which ends July 31, according to Pres. Northrop. Unfilled orders are $53,500,000. Company's Salisbury Motors Div. is expected to develop sales of about $10,000,000 annually.

Sendix Helicopter, Inc., reports organizational and registration expenses of $118,981 in '45. Current assets were $1,288,348 at end of 1945, of which $1,163,273 consisted of cash. Current liabilities were put at $19,705.

Sajor reports '45 net income of $298,918 or 93c a share against '44 net income of $443,692 or $1.43 a share.

Colonial Air Lines stockholders have approved an increase from 500,000 to 1,000,000 shares in authorized capital stock, but company has no present intention to augment its 365,600 outstanding shares by a further issue.

Commonwealth Aircraft has private plane backlog of unfilled orders totalling $40,000,000, according to Pres. Voyes.

United Aircraft has enough orders on hand to keep its 20,000 workers busy until middle of '47, according to Chairman Rentschler. Company has settled its account of $723,000,000 in terminated government military orders for $52,000,000.

United Air Lines profits in 1946 will be "substantially" lower than last year, Pres. Patterson reports. Company plans some financing in form of bank loans in near future. Passenger revenues are expected to increase about 55% this year, while mail revenues may be down by 30 to 50%.

Douglas will probably break even on 1946 operations. Pres. Douglas told stockholders at annual meeting. He said that airlines were rapidly becoming "over-seated." Although company has considered possibility of making personal planes, Mr. Douglas said nothing tangible has been done along this line to date.

Kollsman Div. of Square D Co. has weathered changeover from strictly war production to peacetime output, and its prospects are bright, according to Pres. Magin Kollsman's current sales, he recently told stockholders, "is greater than we had expected."

Piper has registered 150,000 shares of 4½% stock for sale to public. Proceeds will be used to retire a $93,000 mortgage and to pay bank loans of $400,000. Increase in working capital is desirable according to company officials, due to need for carrying increased inventories.

★ OBITUARY ★

Alex Papana, well-known test pilot and stunt flyer. . . . He once served as personal pilot to King Carol of Rumania and after arrival in U. S. in 1932 he flew at the National Air Races, distinguishing himself in precision aerobatics. As test pilot, he was successively associated with various aircraft makers, and he recently organized his own test service group.

Sterm W. Archer, consulting engineer for Ampco Metal and formerly professor of aeronautics at Tampa U. An Army pilot in World War I, he later participated (1927) in a world flight from N. Y. to Bombay and return.

ADDING IT UP . . . By RAYMOND HOADLEY

Airline Financing. More than 600 airliners costing from $200,000 to $1,500,000 each have been ordered by American airlines—and now the time is fast approaching for payment on some of these contracts. Deliveries are already under way on some orders, will soon start on others. One line is reported seeking a rather large loan from RFC, while another expects to negotiate some private bank loans to take care of its $52,000,000 expansion requirements over the next 12 to 18 months. Late 1947 is expected to see some 1,095 airliners in operation, as against a current total of 522 craft owned.

Export-Import Bank. Several airlines are reliably reported to have approached the Export-Import Bank for equipment loans, only to receive complete turn-downs to date. The bank's attitude, as one of its officials explained it to us is that the airlines have sufficient credit standing to do their necessary financing in the usual channels instead of going to the government for assistance. Export-Import Bank did make a loan to TACA lines some time ago, but officials maintain that this was a special situation and should not be considered a precedent for large-scale financing of domestic lines by the bank.

Reports to Stockholders. N. Y. Stock Exchange has been a bit irked at aircraft companies listed on the Big Board—for being too miserly with their interim reports to stockholders. Taking the tip, it's expected that the listed aircraft concerns will hereafter issue quarterly reports, including sales data, earnings and backlogs.

Back to Normalcy. Now that some of the bookkeeping burdens involved in war production are lessening, this stand on the part of Exchange officials seems reasonable. While renegotiation termination etc. have given abundant reason for aircraft concerns to be anywhere from six to ten months late in submitting their past reports, these companies should now be able to get out their annual statements as early as do the other 1,200-odd industrial companies listed on the exchange.

Contract Settlement. Most of the terminated war contracts still awaiting settlement are concentrated in the hands of a few major contractors. Estimated amount of fixed-price claims remaining to be settled is about $3 billion. Based on experience of recent months, these claims will be settled for $2.7 billion. Some $400 million in cost-plus-fixed-fee contracts remain to be paid. Of the underlying subcontracts, 88% have been settled. Moreover 61% of the plant-clearance job was completed by Mar. 31.

Personal Planes. Protests are heard daily from private plane manufacturers that they're unable to get steel, aluminum, long staple cotton and other essential materials. Already forecasts of 1946 lightplane output have been whittled down to 20,000, and now the latter estimate begins to appear to be on the overly optimistic side. Suppliers argue they're often held up by price uncertainties.

FLOYD W. CARLSON, chief helicopter test pilot for Bell Aircraft, has been declared outstanding young man of year by Buffalo Junior Chamber of Commerce, and in recognition thereof he is recipient of Gold Key, emblematic of honor bestowed upon him.

GRANT W. C. McCORA CHIE, gen. mgr. of CPA of Edmonton, has been awarded McKee Trophy for '45 for his outstanding contribution to commercial flying in Canada. A pioneer operator of northern air routes he was educated at University of Alberta.

FRED W. HERMAN, has been appointed plant mgr. for Douglas at company's Long Beach plant, where he was formerly chief engineer. He has been associated with company for 25 yrs. Previously he was with engineering div. of AAF at Dayton, Ohio.

JACOB E. SMART has been named executive vice pres. of Air Power League. A West Point graduate, he was formerly a colonel in AAF, and has served as adviser to Gen. Arnold. He holds a DSC, DFC, and Air Medal with three oak leaf clusters.

COL. FRED M. GLASS has been appointed vice-pres. of PCA in charge of its southern region, with hq. at Washington, D. C. During war, he was chief of staff for Pacific Div., ATC, and before war he acted as airline CAA council. His AAF rank was Col.

MARVIN A. HEIDT has been named vice-pres. in charge of industrial relations for Bendix Aviation. He joined company in '39 as dir. of industrial relations. Previously he served in same capacity for Dodge Brothers and Edward G. Budd Mfg. Co.

LT. COL. L. A. HARDESTY has been appointed director of operations for TACA with hq. in Miami. He was formerly commanding officer of an ATC group operating over "Hump", and had been with AAF since '42. A graduate of U. of Wash., he learned to fly in '30.

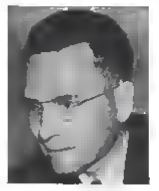
CAPT. OLIVER J. STUREMAR has been named operations mgr. of PAA's Latin American Div., with hq. in Miami. During war he supervised international airline contract operations for RATS. A veteran pilot of more than 20 yrs., he has flown in all parts of globe.

RICHARD W. DARROW has been appointed director of public relations for Glenn L. Martin. Previously he had been mgr. of public and internal relations of CAW, Columbus div. He is a graduate of Ohio Wesleyan University and a member of NAA and APL.

HAROLD M. PARSEKIAN has been appointed director of sales and technical service for Glenn L. Martin's Plastics & Chemicals Div., where he will be in charge of sale of company's new Marvinol polyvinyl resins. He was formerly associated with Bonney & Smith Co.

CHARLES W. PERELLE has been elected pres. of Gar Wood Industries. Formerly v.p. in charge of manufacturing for Convair, he was responsible for company's top record in AAF production ratings. He also installed first mechanized assembly line in aircraft industry.

GEORGE F. CHAPLINE has joined Fairchild's Ranger Aircraft Engines Div. as asst. gen. mgr. He served as a capt. in Navy during War and commanded an air base unit in Marshall Islands. A pilot for over 25 yrs., he is an associate fellow of IAS. (Tommy Weber photo)



CLIFFORD E. ROBERTS has been appointed Washington, D. C. representative, engineering and sales, for Boeing Aircraft. Previously asst. chief engineer for Glenn L. Martin, he served in Naval Reserve as an aviation specialist since '33, and he's owned and flown his own plane.

STEWART FAULKNER has joined CAL as director of advertising and publicity. Formerly he was national promotion mgr. of PCA. During war he was asst. general traffic mgr. and advertising dir. for Lockheed and Alaska Airlines. His hq. will be at Continental's Denver offices.

BRIG. GEN. LAWRENCE J. CARR was elected president of Institute of Air Transportation. A graduate of West Point he was attached to 7th Air Force during war as chief of staff to commander in charge of all land-based aviation. Previously he was with Trans-Caribbean. (Volpe photo)

NEW PRODUCTS

KEEP POSTED ON
Products and Practices

INFORMATION TIPS

This selected information on new publications and products is offered by the "AVIATION" Reader's Service through cooperation with the manufacturers. It helps executives save valuable time, provides profits through convenience. To obtain literature or additional data on new products described, simply fill in form below, clip it to your letterhead, and mail. There is no cost, no obligation.

ENGINEERING

Fluid Measurement 1

Containing engineering data on fluid measurement also related factors of equipment, and computations in terms of steam, water, oil, and gas flow, new handbook has been issued by Brown Instrument Co., Philadelphia.—AVIATION, June, '46

Nael Miller 2

New 16 mm. color sound movie "The Miller That Uses Its Head," announced by Nicholas-Morris Corp., New York City, shows various types of tooling and fixture design, from stock fixtures to completely automatic fixtures.—AVIATION, June '46

Copper Alloy Welding 3

"Welding and Brazing of Copper and Copper Alloys" is new handbook published by C. E. Phillips & Co., Detroit, giving definitions of processes and materials, data on compositions and properties of commonly welded and brazed copper alloys, and information on welding and brazing.—AVIATION, June, '46

Radio in Aviation 4

Various items relative to radio in the aeronautical field are included in Vol. 2 No. 4 of "Sendix Radio Engineer" published by Bendix Aviation Corp., Baltimore.—AVIATION June, '46

Indicating Instruments 5

Publication "Weston Engineering Notes" issued to provide application engineering information to users of electrical indicating instruments is offered by Weston Electrical Instrument Corp., Newark N. J.—AVIATION, June, '46.

Welding Data 6

Giving engineering data and feature article on welding high tensile steel with chrome-moly electrodes, "Welding Briefs" published by Metal and Thermit Corp., New York City, includes other informative on various welding problems.—AVIATION, June, '46.

Replacing Stripped Threads 7

Containing instructions for installing "Heli Coils" in tapped thread repair work, Bulletin No. 300 from Aircraft Screw Products Co., Long Island City, N. Y., also gives specifications and part numbers of accessory tools recommended for use with inserts used in repair of stripped threads.—AVIATION, June, '46.

Cleaning and Drawing Compounds 8

New 24 page catalog from Northwest Chemical Co., Detroit, contains information on five types of cleaning compounds and also on five types of drawing compounds.—AVIATION, June, '46

Slide Rule 9

Folder from Charles Bruning Co., Chicago, describes new slide rules made from plastic material stated to give greater dimensional stability.—AVIATION, June, '46

Flow Meters 10

Bulletin F1005 released by The Bristol Co., Waterbury Conn., describes new bellows type differential flow meter, giving ranges available in both recorders and controllers.—AVIATION, June, '46

Aircraft Tubing 11

Ohio Seamless Tube Co., Shelby, Ohio, has issued new list of aircraft tubing stock. Covered are round, streamlined oval, elliptical, square and rectangular tubing.—AVIATION, June, '46

Lock Nut 12

Folder from Grip Nut Co., Chicago, describes "Gripco" one-piece lock nut stated to be unaffected by oil, water, or chemicals.—AVIATION, June, '46.

Pumps and Stirrers 13

Describing line of midget pumps and laboratory stirrers, new catalog from Eastern Engineering Co., New Haven, Conn., also gives specification and performance data.—AVIATION, June, '46

Tool Steels 14

New brochure describes steel tools, including dies, cutters, cams, and forming rolls, cast to shape by Jessop Steel Co., Washington, Pa. Also given are technical and engineering data.—AVIATION, June, '46.

Friction Tape 15

Stated to give adequate insulation in single layers for lines up to 250v, and in double layers up to 600v, new friction tape is described in catalog section issued by B. F. Goodrich Co., Akron, Ohio.—AVIATION, June, '46.

Feed Calculator 16

New slide-rule type devices for calculation proper feed per tooth for all types of carbide milling cutters is described in literature from Wendt-Sonis Co., Hannibal, Mo.—AVIATION, June, '46

Tap Extractors 17

Folder from Walton Co., Hartford, Conn., describes line of tap extractors for standard hand taps, machine screw taps, and pipe taps.—AVIATION, June, '46

Surface Inspection 18

"Faxfilm", described in literature from Faxfilm Co., Cleveland, is designation for company's material and method enabling naked eye examination of details of various surfaces and which without photography, makes permanent record of surfaces studied.—AVIATION, June, '46

Drill Chip Breaker 19

Bulletin No. 5818 issued by Continental Tool Works Detroit, describes drill chip breaker giving installation and operating instructions as well as technical information on drilling practice.—AVIATION, June, '46

MACHINERY & ACCESSORIES

Surface Quality Control 20

Catalog from Physicists Research Co., Ann Arbor, Mich., describes profilometer for measuring quality of metal surfaces, giving specifications and applications.—AVIATION, June, 46.

Infra-Red Units 21

Specifications and descriptions of infra-red lamp units are given in bulletin from Miskella Infra-Red Co., Cleveland.—AVIATION, June, '46.

Live Centers 22

Stardomatic Tool Co., Detroit, has released new catalog describing live centers made with standard Morse taper covering

AVIATION READER'S SERVICE

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NEW PRODUCTS:						57	58	59	60	61	62	63	64	65	66	67	68	69
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special purpose applications, and giving specifications —AVIATION, June, '46

Machine Tools 23

Catalog from Zagar Tool Co., Cleveland describes line of collet chucks, broaching machines, and multiple drill heads giving specifications, technical data, and special features —AVIATION, June, '46

Guide Post Bushings 24

Bulletin No. 40 from Ampco Metal, Milwaukee describes line of aluminum bronze guide post bushings furnished in standard sizes and available from stock —AVIATION, June, '46

Carbide Tools 25

Specifications of carbide tools and masonry drills are given in bulletin from Metro Tool & Gage Co., Chicago —AVIATION, June, '46

Surplus Machine Tools 26

Booklet issued by National Machine Tool Builders Assn., Cleveland, gives questions and answers on how to buy government-owned surplus machine tools. Included is list of surplus sales and information offices. Formula for determining prices of standard tools, and regulations affecting sale of equipment —AVIATION, June, '46

Gages 27

Herberg Gage Co., Bridgeport, Conn., announces Bulletin B concerning sets of drill size pin gages, numbered, lettered, or fraction type —AVIATION, June, '46

Screw Machine Drills 28

Designed for operations requiring short drills, line of stub screw machine drills is described in circular from Chicago Latrobe Twist Drill Works, Chicago —AVIATION, June, '46

Industrial X-Ray 29

List of about 400 articles on industrial radiology (supplementing references in "Industrial Radiology" published in 1943 by John Wiley & Sons) includes authors, titles and locations. Compiled by H. R. Isenburger, list is available from St. John X-Ray Service, Inc., Cullen, N. J. Charge is $1.00 —AVIATION, June, '46

Head Screw Machine 30

Catalog from Wada Tool Co., Waltham, Mass., describes new head screw machines intended for modern, fast, economical production of second operation work —AVIATION, June, '46

Openside Planer 31

Containing facts about design construction, and operation of openside planer, brochure No. 910, issued by Rockford Machine Tool Co., Rockford, Ill., also gives specifications on four rated sizes, each available in five stroke lengths from 10 to 20 ft —AVIATION, June, '46

Carbide Tipped Face Mills 32

Bulletin No. FM-46 from Tungsten Carbide Tool Co., Detroit describes new standard Vibra-Cushioned carbide tipped face mills. Fastened are inserted and fixed blade type of cutters for steel milling —AVIATION, June '46.

Collets and Feed Fingers 33

Specifications and description of line of collets and feed fingers for automatic and hand screw machines, lathes, and milling machines are given in new 36-page catalog from Sutton Tool Co., Sturgis, Mich —AVIATION, June, '46.

Pneumatic Positioners 34

Designed for operating remote indicators, recorders, and flow controllers for adjusting flow controller settings from remote points, and for positioning automatic rate control units, pneumatic positioner is described in Bulletin No. 45-A from Fischer & Porter Co., Hatboro, Pa —AVIATION, June, '46

Flexible Shaft Grinder 35

Literature from Spring Specialty Co., Maywood, Ill., describes Model VS-1 flexible shaft grinder operating at 14,000 rpm and accommodating ⅛, ¼, and ½ in arbors —AVIATION, June, '46

Lubricating Brush 36

Designed to lubricate and clean taps, drills and reams mounted on drill presses, and also punches, "Lubro-Brush" is described in catalog issued by Charles L. Jarvis Co., Middletown, Conn —AVIATION, June, '46.

ELECTRICAL

Relays 37

Bulletin 130 issued by Ward Leonard Electric Co., Mount Vernon, N. Y., describes line of relays available —AVIATION, June, '46

Electronics 38

Articles on specific electronic applications and explanation of electronic theory, and basic electronic devices are featured in new booklet "Electronics Digest" issued by Westinghouse Electric Corp., Pittsburgh.—AVIATION, June, '46

Battery Chargers 39

Specifications and description of motor-generator multiple circuit type battery charger for hand-lift trucks, are contained in Bulletin No. 105 from Electric Products Co., Cleveland.—AVIATION, June, '46

Radio Interference Filters 40

Catalog from Sprague Products Co., North Adams, Mass., gives information on construction, installation, and performance of "Filtercel" radio interference filters —AVIATION, June, '46

Switches 41

Handbook No. 130 from General Control Co., Boston, Mass., describes line of lever switches for radio, signal equipment and electronic devices —AVIATION, June, '46

Resistors 42

Containing information on line of "Ritechm ½ and 1W non-inductive pie-wound resistors, Bulletin No. 120, issued by Ohmite Mfg. Co., Chicago, gives electrical, mechanical and dimensional data.—AVIATION, June, '46.

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ELEVEN Ryerson Steel-Service Plants provide unmatched facilities virtually next door to every steel user in the principal markets of the United States. Though many sizes are missing because of the steel shortage, each Ryerson plant has large, diversified stocks. Each is backed up by the inventories and facilities of the others. These strategically located steel stocks plus modern high speed equipment are your assurance that orders will be filled accurately and promptly.

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RYERSON STEEL

STEELS

Stainless Steel 43

Allegheny Ludlum Steel Corp., Brackenridge, Pa., has issued handbook on various types of stainless steels, including finder table, corrosion resistance, discussions of properties, and fabricating methods.—AVIATION, June, '46

Corrosion of Steels 44

Containing information on how various types of commercial steels may be expected to resist attack of atmospheric corrosion, booklet "Corrosion of Steels" has been issued by Carnegie-Illinois Steel Corp., Pittsburgh —AVIATION, June, '46

PLASTICS

Protective Coverings 45

Literature from Celanese Plastics Corp., New York City, contains descriptions, technical data, and types of applications of "Lumarith" plastic sheets and foils —AVIATION, June, '46

PLANT SERVICE

Fire Extinguisher 46

Folder issued by Randolph Laboratories, Inc., Bridgeport, describes new 2½-lb CO_2 fire extinguisher featuring trigger-touch release. —AVIATION, June, '46

Foam Type Extinguisher 47

Brochure from Pyrene Mfg. Co., Newark, N. J., describes air foam as fire fighting material and includes information on what it is, how it works, and applications.—AVIATION, June, '46

AIRCRAFT & ACCESSORIES

Tachometers 48

Line of tachometers including centrifugal, chronometric, vibrating reed, and portable and stationary types is described in Bulletin No. 1040 from Herman H. Sticht Co., New York City —AVIATION, June, '46

Photographic Equipment 49

Booklet from Abrams Instrument Corp., Lansing, Mich., covers line of photographic equipment for aerial map work, including vertical and oblique cameras, contour finders, control timers, mechanical triangulators, combat cameras, and grinding boxes —AVIATION, June, '46

AIRPORTS

Generators 50

Bulletin L-460 from Homelite Corp., Port Chester, N. Y., describes portable gasoline driven generators ranging in size from 500 to 3,000w ac or dc, 0 to 230v, and 60 to 400 cycle —AVIATION, June, '46

Hangars 51

Featuring innovations in hangar design, bulletin from Star Manufacturing Co., Oklahoma City, describes construction of company units.—AVIATION, June, '46

Facsimile Machine 52

Designed for transmission and reception of messages at high speed including written material, pictures, and weather maps, two new facsimile machines—one for handling 30,000 words per hour or 2,700 sq. in. of picture copy, other unit for slower speed for automatic framing and election of messages—are described in literature from Finch Telecommunications, Passaic, N. J. —AVIATION, June, '46

Excavator 53

Folder from Trackson Co., Milwaukee, describes Model 1T4 earth moving shovel to be operated with crawler tractor in excavating, grading, loading, and material handling jobs.—AVIATION, June, '46

Cable Raceway 54

Designed to enable planes to land and takeoff without coming in contact with ground is special cable runway described in folder from Brodie Engineering Corp., Baltimore. Apparatus consists of cables stretched taut between masts, with hook-on device provided for aircraft. Cable runway is intended for employment in locations where use of a conventional landing strip is not feasible —AVIATION, June, '46.

MANAGSMENT & EMPLOYSES

Training Films 55

Catalog published by Castle Films, New York City, describes collection of educational and training films now available to industry—AVIATION, June, '46

MERCNANDISING

Sales Aid 56

Literature from Polaroid Corp., Cambridge, Mass., describes two new products developed as sales aids. Selectographs designed to present "before and after" effects and Vectographs, designed to show three dimensional pictures.—AVIATION, June, '46

NEW·PRODUCTS

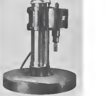
Machinery & Accessories

Metal-Cutting Band Saw 57

For cutting sheet steel aluminum ferrous and non-ferrous castings, as well as paper, wood, plastics, laminates and composition materials, new band saw, "Zephyr 16", is announced by DoAll Co., Minneapolis.—AVIATION, June, '46

Pneumatic Column Press 58

Particularly useful for small to medium runs where it is desirable to leave fixtures mounted to base, new air operated column press is announced by Mead Specialties Co., Chicago. Unit can deliver ram force of 2,030 lb on 110-lb line pressure. With column press, successive operations may be performed by swinging ram over desired fixture, raising or lowering to right height



with raising screw, and locking in place with drawbolts. In some cases a dozen or more small jobs may be left set up. Height over all, excluding handle is 24⅝ in., dia. of table is 23½ in., stroke 8 in., clearance of ram above table 11 in., depth of throat 4⅝ in., and weight 265 lb. Power factor is 2½ times line pressure.—AVIATION, June, '46

Slotting Cutter 59

Control of blade settings obtained by screw adjustment to blade locking device is feature of Type B slotting cutter made by Lovejoy Tool Co., Springfield, Vt. To adjust blade, either for resharpening or for

controlling slot width, locking device is loosened by unseating taper pin. A recessed head screw at bottom of each blade is turned to move blade. Blade is locked in body by reseating taper pin. Positive and negative rake cutters are available in face widths from 7/16 to 1½ in. and diameters from 5 to 16 in. Cutters are equipped with tungsten carbide tipped high speed steel or cast alloy blades.—AVIATION, June, '46

Shop Equipment & Materials

Harness Clamp 60

Holding a variation of group diameters of wiring bundles, new strap-type harness clamp installation has been developed by Tinnerman Products, Cleveland, to permit a greater flexibility of application. To fasten

clamp, strap is looped around bundle of wires and slipped under loose locking roller in bracket. Strap is then pulled tight in opposite direction and roller is then forced into locked position. To release, two heads of roller are pressed to snap it back into free position. Strap made of Neoprene coated fabric to withstand minus 65 to plus 180 deg., is fungus resistant.—AVIATION, June, '46

Lightweight Plastic 61

Envisioned for use as strong, lightweight cores in airplane floor panels, tail assemblies, wing structures and for other uses new foamed plastic is made by E. I. du Pont de Nemours & Co., Wilmington, Del. Lighter than cork maker states it has virtually same insulating properties as cork, balsa wood, and other rigid insulating materials. When this cellular cellulose acetate material is bonded between two panels of metal, wood, or another plastic, it is said to be non-compressible except under extreme pressures. Its heat resistance is such that thermosetting resins can be used to cement it. Plastic is now made in strips 6½ in. long and ⅝ in. thick. Thicker and wider pieces will be made soon, but present strips may be glued together to form thick sections. Material may be tooled or shaped with any woodworking machinery.—AVIATION, June, '46

Motor Resists Dust 62

Available in standard explosion proof and dust explosion proof types from 1 to 1600 hp., new totally enclosed fan-cooled motor designed for use in dusty, dirty and corrosive atmospheres, has been added to line of "Tri-Clad" induction motors made by General Electric Co., Schenectady, N. Y. Short in length, motors have low starting current, with balanced design making units suitable for full voltage starting.—AVIATION, June, '46

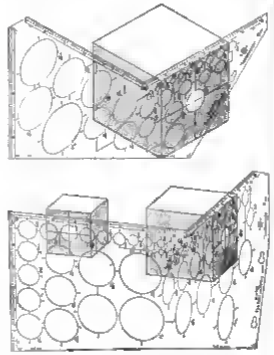
Metal Cleaner 63

Permitting a choice of several cleaning cycles new conveyorized two-dip immersion vapor degreaser made by Detrex Corp., Detroit, is designed to handle small bulk parts. Two methods of cleaning are offered. One is immersion vapor cycle. Work being cleaned is dipped in hot solvent in first chamber and is moved through vapor in second. Other selection is vapor-immersion vapor cycle where solvent level is held low in first chamber allowing accumulation of oils and grease as in one dip concentrator. Conveyor then moves through hot solvent in second chamber and then through solvent vapors in second phase. Boil-rinse vapor cycle cleans work in

solvent at a boil temperature, at a rinse temperature and in vapor. Work is loaded at one end, carried through cleaning cycle, and returned through upper head to same end of machine for unloading. Known as 500-C-1, degreasers have capacities of 2,000 to 4,000 lb per hour. There are eight basket sizes ranging from 4 x 14 x 6 in. to 18 x 60 x 12 in.—AVIATION, June, '46.

Stencil Drafting Instruments 64

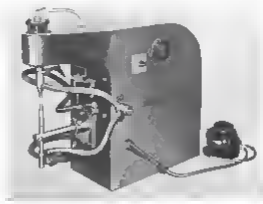
Draftsmen may make isometric or dimetric drawings by using two new "Instrumaster" stencils, without using other devices. Both are cut from clear plastic, about .040 in. gage, with graduations and lettering debossed on lower side. Made by Instrumaster Industries, Greenwich, Conn., stencils provide inch graduations at



full scale along one vertical and two slanted edges. These edges represent correct directions of isometric and dimetric axes. Each stencil has 17 ellipse openings representing in individual projections, circles from ⅛ to 2 in. dia. By placing one edge against T-square, graduated edges as well as ellipse openings assume required position within drawing. Lines and small holes indicate center lines of ellipses. Ellipse sizes are indicated by size of circle to be represented not by major axis. Same type stencils are made with ellipses ranging from ⅜ to 4½ in.—AVIATION, June, '46.

Spot Welder 65

Air operated foot-controlled electronically timed and with adjustable pressure switch new bench type spot-welder, announced by Weldex, Inc., Detroit, is 5 hp., 220v., 60



cycle, single-phase unit. Known as Model 269-A, it is recommended for welding of lightweight metals up to 16 gage. Machine is 21 in. high, 16 in. wide, and 28 in. deep. Weight is about 125 lb.—AVIATION, June, '46.

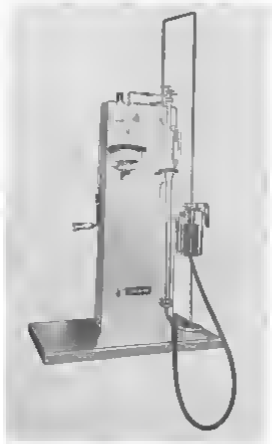
Bright Dip 66

Developed to form a corrosion resistant finish on surface of metal, "Iridite Bright", is chemical treatment stated to produce mirror-bright transparent chromate film on zinc or cadmium plated parts. No electric

current is used in process. Parts being treated are immersed in solution for 5 sec. and rinsing and drying follows. Product is made by Rhamp Research Products, Baltimore.—AVIATION, June, '46

Carbon Determinometer 67

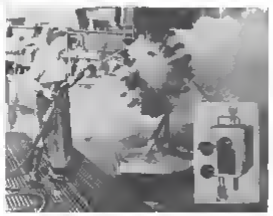
For use in analyzing carbon in iron, steel, heat resisting steel, stainless steel and other materials new volumetric type carbon determinometer, made by Lindberg Engineering Co., Chicago, has burette mounted in front of a fluorescent light. Buralte is water jacketed and graduated



for 1 gram and ¼ gram samples. Chamber which permits absorption in two passes and for many alloys in one pass, combines use of glass tubing and glass beads. Friction clamp holds leveling bulb at any point. Micrometer screw is used for zero adjustment.—AVIATION, June, '46

Steam Cleaning Unit. 63

Suitable for use in cleaning engine parts, and for other shop uses, new Hydro Steam unit is designed to operate from any steam line of 80 to 150 lb. pressure with a ¾ in



valve outlet. Maker is Turco Products Co., Los Angeles. There are three manual controls to vary temperature, quantity of solution and nozzle pressure. Unit can be adjusted to deliver high temperature, penetrating spray, or warm spray. There are no moving parts, pumps, pressure tanks, motors, or electrical connections. Weight is 28 lb.—AVIATION, June, '46

Assembly Bin Hopper. 69

Designed to increase capacity of assembly bins nearly four times, to save bench space, and reduce interruptions of work, new bin hoppers made by Slushbin Corp.,

Providence, R. I., are tapered toward front to form semi-circle. Sloping floors feed parts toward front. Hopper is made of sheet steel with welded construction. When attached to bin it becomes rigid and nests without fastening tools.—AVIATION, June, '46

Decimal Tolerance Indicator 70

Having dial markings in decimals and therefore comparable to blueprint tolerances, new series of indicators has been introduced by Standard Gage Co., Poughkeepsie, N. Y. Advantages are stated to include modified range on dial, elimination

of possibility of failure to notice complete revolution of dial, freedom of whip and waver of hand, consistent repeatability and operation under low tension. Mounting dimensions are in accordance with American gage design standards. Indicators are made in both English and metric units.—AVIATION, June, '46

Two-in-One Hammer 71

Developed for use wherever a solid blow must be struck without injury to work, new dual rubber and steel headed hammer is made by Dan Mercy, Los Angeles, for use in plane factories and repair bases. Rubber head is replaceable by pressing on new head in vise. Shank and head is drop forging, heat treated and polished. Soft head is of 2-in. dia. and made of truck rubber. Steel head is of 1½ in. dia.—AVIATION, June, '46

Electrical Appliances

Four-Channel Transmitter 72

Designed to supply 50w. of output power, new four channel transmitter, Model No.

AVT 40, made by Engineering Products Div., Radio Corp. of America, Camden, N. J., permits selection at any one of four pre-tuned frequencies by turn of a switch. Transmitter and its dynamotor are contained in shock-mounted metal cabinet. Only additional unit is master remote control box, which may be located anywhere within 15 ft. of transmitter. Frequencies are available within range of 3 to 18 mc. Instead of fuses, new unit has manual re-set type of thermal circuit breaker mounted on front panel. Designed for either 12 or 24v. operation, transmitter does not have to be rebuilt if transferred from one plane to another of different voltage. Conversion involves only changes of dynamotor, circuit breaker, and control box pilot lamp. Dual voltage relays are used throughout. Unit weighs about 40 lb.—AVIATION, June, '46

Molded Coil Forms 73

Made with anchored hairpin wire leads, molded bakelite coil forms announced by Electronic Components Div., Stackpole Carbon Co., St. Marys, Pa., have uses ranging from universal and lapped universal windings to solenoid windings, antenna or coupled windings, and iron cored I-F transformer or coupled coils. Standard types include forms with coaxial leads each end, single hairpin leads each end, single hairpin leads one end, double hairpin lead other end, and double hairpin lead each end. If desired, coils may be wound on separate tubes and slipped over forms, or winding may be done on forms direct. Where required, forms are supplied with molded iron sleeve cores.—AVIATION, June, '46

Test Lamp 74

Designed for checking wiring, switches, relays, coils, resistors, starters, fuses, generators, ignition systems, also lamps for short circuits, open circuits, and grounds, new plug-in test lamp is announced by Hanlan Co., Los Angeles. It operates on any 110v. outlet.—AVIATION, June, '46.

Aircraft Parts & Field Units

Fueling Ladder 75

Designed to accommodate any large plane, new fueling ladder made by Hammond Mfg. Corp., Huntington Park, Cal., is made of steel tubing. Employing roller bearings, front wheels have 8 in. casters with molded tire, while 12-in. casters are used on back wheels. Operated by a hand winch, ladder extends from 6 ft. 7 in. to 18 ft. Unit has safety locking pin and dogs, and steps have

safety tread. Nozzle of hose is held by sheave and is raised with aid of pedal weight is about 600 lb —AVIATION, June '46.

Reflector Floodlight Bulb 76

Useful for emergency field work repairs, and other applications new floodlight made by Wabash Corp., Brooklyn N. Y., has silver reflector lining hermetically sealed inside, with filament mounted at focal point. Light beam, moderately concentrated between 5 to 60 deg zone feathers away in diffusion at edges. Built in of 5 in dia. and 6¼ in. long and can be used in any standard socket, swivel type socket or recessed ceiling fixture. Stated to have a life of 2,000 hr., floodlight is available in 150, 200, 400 and 500w sizes —AVIATION, June, '46.

Aircraft Radio 77

Lear, Grand Rapids Mich., announces Model TR-28 aircraft radio, designed to cover beacon and commercial broadcast frequencies, furnishing two way communication, avigational aid on radio ranges, aerialainment programs, and direction finding when tuned to standard broadcast stations. Weighing 10 lb., set includes transmitter receiver, power supply, head phones, and microphones. It is divided into two units with control unit mounted on instrument panel, and power unit remotely located in plane. Transmitter is crystal controlled oscillator, power amplifier, and modulator and has output of 12w. Receiver is superheterodyne with a stage of radio frequency amplification. Receiver antenna is stated to have sensitivity of 5mv per meter with 4-to-1 noise ratio at 00 mw. output on one

ANNOUNCEMENTS—

at new machinery, shop equipment and materials, electrical appliances, and aircraft parts and field units are invited

In writing, emphasis upon specific aviation applications of newly marketed items is desirable. Also whenever possible, glossy-print photos should be enclosed. Please do not send electros. Address—

New Products Editor, AVIATION
330 W 42d St, New York City 18

hand, and on other hand a sensitivity of 5 to 10 mv. with noise ratio of 4 to 1. Sensitivity is 50 to 60 mv. when used as aural-null direction finder employing a loop —AVIATION, June, '46.

Metal Propeller 78

New metal propeller, "Mel-L Prop" made by McCauley Corp., Dayton, Ohio is described as shortening takeoff run increasing rate of climb, and enabling faster cruising speed without sacrificing takeoff performance. Designed for small personal

planes this thin sectioned light aluminum airscrew is stated to give extra long life and reduce maintenance expense —AVIATION, June, '46.

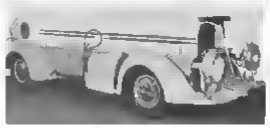
Beam Controlled Light 79

Developed to permit safe landings when ground visibility is down to ¾ mi. new beam controlled light is made by Line Material Co., Milwaukee. Lights used on

both sides of approach or runway are stated to be glare free high intensity units. They are designed to be used on a fixed focus with brightness controlled for average visibility or they may have a remotely controlled variable beam for operation under lower limits —AVIATION, June, '46.

Power-and-Service Truck 80

Motorized truck designed to deliver 12 and 24V electric power to airplanes, and also to handle water, alcohol oil and air



STANDARD SHAPES OF
REVERE MAGNESIUM
MAKE THESE BODIES 1500 lbs. LIGHTER

BUILT BY Barry and Baily Company in Philadelphia *without previous experience in working with magnesium*, these panel bodies for American Stores Company weigh approximately 1500 pounds less than similar bodies of steel!

Standard shapes of magnesium alloy, especially engineered by Revere and readily available from stock, make possible this remarkable advance in truck bodies. Now, for the first time, body builders and fleet operators can use magnesium with the same ease as steel. All sheet metal forming is eliminated through this Revere development. Structural members are all pre-designed in accordance with the engineering properties of high-strength magnesium alloys. None but familiar methods of fabrication and assembly are involved . . . clamping, drilling, riveting.

Full Latitude for the Body Designer. Bodies built with these standard materials may be large or small, may include any type of floor desired, may conform to individual designs, may be mounted on any make of chassis.

From the illustrations of this body under construction by Barry and Baily, you can see how simply and neatly the specially engineered Revere parts go together. The standard members consist of extruded floor beams, corner posts, crown sill sections, side posts and roof carlines, structural angle section, roof corner castings, and sheet for all exterior panels.

Dent Resisting Corner Post. Two features are especially noteworthy and are shown here in detail. One is the composite corner post design. The inner post is a rugged member with a protrusion at its center running its entire length. This supports the strong outer shell at its most vulnerable point, and entirely eliminates the need for hand-fitted wooden reinforcing blocks. Because this post provides a smoothly rounded corner, the sheet for exterior paneling need only be fastened flat between the inner and outer members by means of rivets.

A Rugged Roof Rail. Not only is the roof rail exceptionally sturdy to resist abnormal punishment in service, but it securely unites side, end and roof panels into a rugged, unified structure of excellent appearance because of the generous radii employed. A decorative top trim designed as a scuff rail serves to ward off overhanging obstacles that might damage rivet heads. The roof corner is a massive magnesium alloy casting. Thus, as well as side posts, roof carlines and reinforcing angle sections, are all joined to the roof rail with machine screws or bolts.

Let Revere Help Lighten Your Equipment. Revere's standard magnesium alloy shapes have been engineered to make the building of ultra light panel bodies simple, easy and inexpensive. But truck bodies are only one type of equipment which Revere magnesium can lighten. In collaboration with your own engineers, a Revere Technical Advisor will gladly assist in the application of magnesium to your products. That is the way to get more payload into your transportation equipment . . . on the ground or in the air.

For full details on Revere's standard magnesium alloy shapes for truck bodies and on other Revere magnesium products, get in touch with the nearest Revere office.

REVERE
COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
230 Park Avenue, New York 17, New York
Mills: Baltimore, Md., Chicago, Ill., Detroit, Mich., New Bedford, Mass., Rome, N. Y.
Sales Offices in Principal Cities

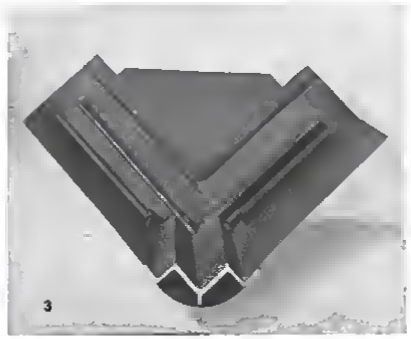
Listen to *Exploring the Unknown* on the Mutual Network every Sunday evening, 9 to 9:30 p. m., EDST.

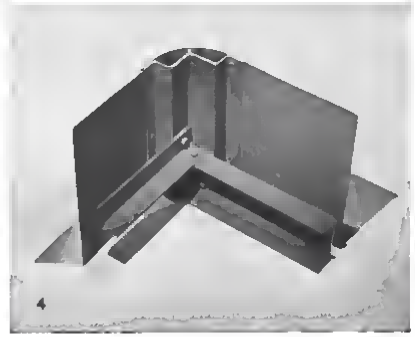
(1) 5 ton American States panel truck. Finished weight of body approximately 2100 pounds. American Stores Company has two of these trucks now in service.

(2) Inside body dimensions 180" long, 86" wide, 75" high. Flooring 1⅛" oak. Lining, ¼" fir plywood. Insulation 2" fiberglass in roof and sides.

(3) Detail of roof rail assembly showing roof rail member, side post, roof carline reinforcing angles and corner casting as seen from inside.

(4) Detail of corner post assembly showing how side and end panels are riveted to the composite corner member.





nitrogen and oxygen of 2,000 psi is offered by Couse Manufacturing, Inc., of Newark, N. J. Chassis-body can be separated into two parts for easy overhaul or for shipment of unit by air. Power delivery: 14v plane, 425 amp. generator or 450 amp battery, 24v plane 400 amp continuous or 800 amp intermittent.—AVIATION, June '46.

Pilot Lip Microphone 81

Featuring new head harness design, lip-type carbon microphone, weighing 5/16 oz has been developed by Aviometer Corp., New York City. Headphone supports micro-

phone free of face, keeping phone at point of optimum speech reception regardless of movement of operator. Unit was recently adopted by Swedish Air Lines.—AVIATION, June '46.

Recent Books

AIRSHIP OPERATION, WORLD WAR 2. Available from USN Base, Lakehurst, N. J. 56 pages. $.50

This booklet renders a graphic account of the part played by lighter-than-air naval craft in the late war, covering the period from Dec. 7, 1941, to Sept. 1945. Profusely illustrated.

RUBBER IN ENGINEERING. Chemical Publishing Co., Brooklyn, N. Y. 267 pages. $5.50

Prepared under the direction of the Controller of Chemical Research of the Ministry of Supply and the Directors of Scientific Research of the Ministry of Aircraft Production in Britain, this book treats of rubber in modern engineering. The problems of both manufacturer and consumer are discussed in detail. Theoretical and practical data are presented to demonstrate how certain variables, ignored in other engineering materials, are of fundamental importance in the case of rubber. The book contains many tables, graphs, and charts.

THE HOW OF THE HELICOPTER, by Alfred H. Stevens, Jr. Cornell Maritime Press, N. Y. 58 pages, illustrations. $2.00

Graphically illustrated history and background of the helicopter. Though primarily intended for younger readers, the average adult will beyond question find this book interesting and informative.

YOUR POST WAR PLACE IN AVIATION, by Russ Brinkley. The Aviation Press, Inc., New York City. 96 pages. 50c

This is an inexpensive, newstand type book offered as a handy civil aviation guide for ex-service men, student pilots, airminded high school students, and others seeking a spot in the aviation field.

AIR WORDS, A Popular Aviation Dictionary, edited by Fred Hamann. Superior Publishing Co., Seattle, Wash. 61 pages. $1.50

Those wishing a reference covering the language which flyers speak will find this dictionary of aviation argot comprehensive. The entire history of aviation has been covered, usages from every period in its development being found in Mr. Hamann's book.

THE BUSINESS LAW OF AVIATION, by Gerald O. Dykstra and Lillian G. Dykstra. McGraw-Hill Book Co., N. Y. 523 pages, index. $5.00

This volume is a thorough, workmanlike combined text and case book in aviation law. Its purpose is to present a convenient compilation of the leading court decisions which have involved aspects of aviation and to call attention to the governing federal and state statutes. Analyses and discussions of aeronautical statutes and court decisions are written in simple, concise language. Special attention is given to recent advances which give new bearing, and an entire chapter has been devoted to international aspects.

Industry Publications

ATA is issuing a review of air transportation problems in U. S. delving into many problems faced by carriers. Copies may be had by writing ATA, 1515 Massachusetts Ave., N.W., Washington 5, D. C. ... American Society for Testing Materials released 1945 supplement to its Book of ASTM Standards. Hq. are at 260 So. Broad St., Philadelphia 2. ... CAA has available "Statistical Handbook of Civil Aviation," replete with facts, graphs, and charts covering past year's activities; also being distributed is new consolidated "Airman's Guide," covering Notices to Airmen, Directory of Airports and Air Navigation Radio Aids.

U. S. Naval Air Transport Service has compiled a comprehensive history of its activities entitled, "The Role of NATS in the Pacific War." ... "Reply of the ATA to the National Transportation Inquiry" answers queries put by House of Representatives Subcommittee on Interstate and Foreign Commerce. ... "The Economic Advantages of Integrated Sea-Air Transportation" is new booklet put out by Sea-Air Committee, National Federation of Shipping, Inc., 2600 Woodley Road, N.W., Washington, D. C.

"National Policy for Aviation" covers an integrated program for future aviation development. It is put out by National Planning Assn., 800-21st St., N.W., Washington 6, D. C. ... PICAO, Montreal, Canada, has issued a booklet, "What is PICAO?", explaining the committees functions. ... "How Can the Air Cargo Carrier Use the Services of a Freight Forwarder?" is a pamphlet issued by Edward S. Evans Transportation Research, 435 Woodward Bld., Washington 5, D. C.

A large number of reports on scientific and industrial aviation information obtained mainly in Germany and German-occupied territories have been released for sale by Office of Publication Board, Commerce Dept., Washington 25, D. C. Materials, processes, products, development work and other technical material are encompassed in detail. ... A booklet containing three authoritative considerations of airport developments is available from Airport Div., American Road Builders Assn., 1319 F St., N.W., Washington 4, D. C.

Follow-Up Clinches Sales

(Continued from Page 51)

follow through in an effort to arrange financing, or to sell flying time, or to supply some other less expensive product or service. He quickly loses interest in the prospect and neglects to develop other lucrative possibilities.

Many a dealer sells only to those who offer the least resistance during first contact. He skims the cream of the territory, and then is through. Thus he continually loses an investment in time, energy, and expense—wastes it by giving up too soon on prospects who require persistent follow up. Records in all lines of selling indicate that most sales are closed on fourth and later calls.

Business veterans profit by following up every potential prospect—hanging on with the tenacity of a bulldog until they are thoroughly convinced a sale of some product or service is impossible. These sales experts have come to recognize, in every day's work, the danger of letting mental deflectors swerve them from a predetermined course of action. Temptations to stop plugging must be brushed aside.

Through experience they have learned that in normal times, four out of five airplane sales are financed on easy monthly payments, eliminating the need for abnormal cash outlays, also that eventually the present owner's airplane will wear out and he will buy a new one, even though he procrastinates at the moment. The experienced dealer knows that if he persists long enough—on a flight student, a visitor, a businessman, or other person in the community—he will close an order. And he knows that his average competition will not persist, thus finally giving him the inside track.

On the other hand, the inexperienced dealer is apt to be deflected in his follow-ups and not realize that persistence of purpose is one of the golden keys to successful selling. Here are seven of the fallacious philosophies commonly voiced by the inexperienced dealer, with the weakness in each pointed out.

1 *"Making sales calls takes too much time. I'm too busy giving flight instruction, keeping the books, handling customers, and managing my business to get away for sales calls."* Following up on sales does take time, but it will pay off in future business. You should analyze your sales schedules to determine what duties can be transferred to someone else, even part time, so that your efforts may be expended in more profitable and productive work. A definite amount of time should be devoted to selling students and other prospects who visit the airport. These potential buyers should be taken care of before looking for others.

2 *"I'll never be a good salesman because people turn me down."* That's because you are new in selling. After a while your failures will slip off your back like a summer breeze. You'll expect turndowns, according to the law of averages—and by the same law, you will make sales.

3 *"There's too much sales resistance to this plane. I'd like to change to one that is more in demand."* Remember, your earnings rise in direct proportion to the resistance you overcome.

4. *"My territory is saturated. I want a bigger area that will give me more prospects."* Are you guessing, or do you really know the exact saturation of your present territory? Have you really tried to sell to all possible prospects, or have you just skimmed the cream?

5 *"I'm going to get another franchise because I'm not getting the proper cooperation from the factory or my distributor."* You may or may not be getting enough cooperation. Go to the proper person and check carefully on that. Perhaps the extent of the help you expect cannot be realized because the profits on the plans or product do

not justify it. If more cooperation would help sell more planes, the company is hurting itself if it withholds such aid.

6. *"There's no use in following up that prospect further—he won't buy until the first of the year."* That is one of the oldest excuses for not buying known to salesmen. Ignore such statements and keep after the sale.

7. *"Without lifting a finger, I can sell all the airplanes the factory can send me."* Currently, this feeling is all too prevalent due to the pent up demand for new airplanes. If your first closures come too easily, you may take on a defeator that may affect your sales record in the long run, and soften you so that later you will find it difficult to meet real sales resistance. Don't let up.

By what program can the dealer develop sales-clinching follow up habits? First, a policy of persistency must be established, then a mechanical routine must be set up whereby the dealer automatically follows through.

A mechanical method for following up prospects involves telephone calls, post cards, and letters. Keeping in touch with the prospective purchaser is vital. The dealer should keep his goal, his quota, and his program graphically in front of him. It should work for him every day, reminding him of what he has previously planned to accomplish, and showing him just how far he has proceeded. A dealer often fails to carry through to a successful conclusion because he forgets what he started out to achieve.

A unique and effective follow-up system is covered in the five-point prospect card (see illustrations) used by Anderson Air Activities, of Milwaukee. It not only points out where to find prospects, but keeps a detailed check on the progress of the sale. There is no let up until every one of the methods outlined on the card has been checked off.

The dealer will find that this system, or a similar one, will get him results—and it will help him to finish what he has started.

Racket Research

(*Continued from page 41*)

like a projectile fired with the same speed and direction from a gun.

The rocket rises vertically at first, and slowly, but travels ever faster (max acceleration 6G) until about a minute later it reaches the cut-off value over 3,000 mph.—nearly five times the velocity of sound. The jet flame which helped to keep it in sight ceases and it is lost to view. It is terrifying to watch even from 1,000 ft. distance, because it soon appears to be directly overhead, and air currents disarrange the smoke generated at fuel cut-offs. You assume flight is erratic.

Seventeen triangulated checking stations are used in tracking V-2, with which four different tracking methods were used May 10: radar, optical, photo, and sonic (Doppler). The radar methods involve radar impulses from a unit in the nose and reflections from three tail surfaces. Both optical and photo (the latter for record) are achieved with an ingenious German instrument, the Askino theodolite, set up 8 to 10 mi. from the launching site. The unit has a tremendous lens, which enables two operators to watch the V-2 for 150 mi. *visually*. A built-in camera records the action at 60 frames per sec. Three of these instruments at widely separated points permit checking of roll of the projectile by showing the special pattern painted on it.

Newly developed radio beacons, which contain their own power supply and are actually miniature radio receiver-transmitters, have been fitted into the V-2 "peacehead" for one tracking device. Antenna are in plastic housings on fins. During flight, the receiver is triggered from a ground radar set by pulses which cause the transmitter to repeat the pulses to the radar. This permits the trajectory to be recorded photographically. The Signal Corps radar set used is modified from a unit developed during the war for detecting hostile aircraft and directing anti-aircraft guns.

Conventional radar equipment also tracks the V-2 for its entire flight without the aid of beacons. As the V-2, as fired on London, contained no electronics guiding equipment, emissions of which might be tracked, this method simulates detection of rockets fired by an enemy.

The V-2 is set for firing by an ingenious elevating beam, designed in Germany for that purpose. It is known as the *Meiller Wagen*, and is long enough to carry the V-2 with ease and set it into place by means of its self-contained, motor driven, hydraulic lifting system. It is equipped with platforms which swing into place, enabling workmen to climb up its built-in ladders to make final tests and adjustments after the rocket is in place for firing. It also carries feed lines for some fuels and stabilizes the V-2 until it is ready to fire. (Other rockets are placed by a 60-ft high crane which operates on wide rails north of the launching platform. On this 1,000 ft of track is also a rail launcher developed by the Germans for the V-2).

Also shown correspondents at the White Sands test was the "WAC Corporal," an all-American design rocket. The WAC Corporal is a liquid-propelled missile—unlike many solid-fuel types developed at Calif. Institute of Technology in a program sponsored by the Ordnance Dept.

The Corporal differs from the V-2 in more than size—it's 1 ft. in diam., 16 ft. long and weighs 700 lb at launching—for it has no control system except three stabilizing fins.

It is launched vertically from a triangular 100 ft. launching tower, and thereafter goes its own merry way, affected by wind, earth rotation and its own peculiarities. These characteristics suggest some of the reasons for the female appellation of "WAC," the "Corporal" coming from the fact that some Army rocket projects are designated by familiar ranks. Suffice it to say, officers in charge of the May 10 test (all married men by the way) were so uncertain of its actions that they kept all observers at the very respectful distance of six mi. Indications were that it—or the two principal parts into which it breaks when its fuel tanks collapse as it reenters the atmosphere, fell into the desert five mi. the other way, but it appeared to be right over this reporter's shrinking scalp when it vanished on its way up.

The WAC also differs from the V-2 in having different chemicals to power pumps which feed propellants to the combustion chamber and in being "boosted" during its first few seconds of flight by a powerful, short-duration solid-fuel step rocket. This brings the WAC to supersonic speed in 0.6 sec., then falls away to let the WAC motor carry on alone. Judging by its actions and by the appellation "Tiny Tim" which officers let slip, this step rocket is a variant of the giant rocket which made a fighter plane able to hurl at an enemy target more high explosive than is carried in a salvo from a light cruiser. Tiny Tim was the first multiple-grain American rocket, having four dry-extruded ballistite grains, each weighing some 40 lb. Its original war head was 150 lb. of TNT.

Presumably, the launching tower could be tilted slightly to "aim" the WAC and payload limitations are believed to be sufficiently large to carry an atomic warhead, but primary present development is to make the WAC a vehicle to carry meteorological instruments into the stratosphere. In tests at White Sands last October, the WAC reached an altitude of 230,000 ft., or 43.5 mi. This elevation was assumed to have been attained in the May 10 test, although radar tracking failed at 55,000 ft. because the rocket was too small to track further by radar.

The WAC costs about $50,000 to make in this country. This could undoubtedly be cut considerably in mass production, but the WAC will probably be discarded in favor of models now

under development. The WAC Sergeant (to anticipate a name as well as to conjecture about characteristics) will probably be thinner-shelled and generally lighter in details, hence able to match the V-2 in altitude and may also carry a higher payload. But officials developing it aren't talking.

Both the V-2 and the WAC will be used to carry instruments into the upper atmosphere in future tests. These will measure temperatures, densities and pressures, make spectographic records, count cosmic rays, take samples of gases, dust and bacteria (if these reach such heights).

Still other measurements are being suggested by scientists from all over the country, indicating that some will be disappointed or more and bigger rockets will be required. Officers conducting the tests also want to make some measurements of their own. Skin temperatures, action of control vanes on the V-2 and their effect where there is no atmosphere for them to act upon are among them.

It is known, for example, that the V-2 does not fall with its axis parallel to its trajectory, until it reenters the atmosphere. For some period after its propulsive power is expended and the earth's gravitational pull begins to pull it back, the V-2 remains in its final uptilted position. Control gyros may activate vanes, but nothing can happen until the vanes have some air against which to push. Then aerodynamic surfaces again become effective.

Skin temperature is estimated to rise to about 600 C (1,300 F.) when atmospheric friction decelerates it from its top speed of 3,500 mph to 2,600 mph before it strikes. Enough of this heat is transmitted to the control chamber that plywood dividers there are scorched. This is of course a problem in instrumentation as well. Scientists thus have three choices:

1. To produce instruments which can stand the shock of striking the earth, the heat of deceleration, and possible explosion of remaining fuels.

2. To use instruments that broadcast to ground recording devices.

3. To devise instrument carriers that will throw them out after desired records are obtained, then parachute them safely to earth.

Of these three, the third appears most advisable, but presents several serious difficulties. What cover material will withstand ejection shock and frictional heat? How can speed be reduced safely, when a conventional parachute will not open where there is no air and would promptly burn anyhow when air friction is encountered at supersonic speed? The parachute could be forced open by an inflatable rim tube operated by a compressed-air bottle, but the heat problem remains. One solution might be to eject the instrument container backward with sufficient force to counteract enough of the rocket's forward speed so skin temperatures stay low. Another is to use metal vanes instead of a 'chute.

Incidentally, there have been frequent press reports of offers by individuals to ride within a V-2 at their own risk. These are true—I read one letter from a sane and responsible New England man of some prominence, who has developed a pressure suit. The V-2 could readily carry him, and the 6G maximum acceleration never approaches the 8 or 9G at which men "black out," so getting him up there would be simple. But how can he be ejected and decelerated without burning to a cinder? And if he stays within the rocket until close above the earth, how can he endure the inside temperature?

Meanwhile, the V-2 provides 20 channels for sending back radio and radar records of its flight. These will be used to examine to the greatest possible extent the outer reaches of the earth's envelope, where cosmic rays and shooting stars abound, beyond the fringes of the atmosphere which acts as a filter for such visitors from interstellar space. Our present knowledge is limited to distances of only 19 mi. above the earth—the V-2 and the WAC to be may make it possible for us to reach out to 150 mi.—or eight times as far.

"Crossroads" Critique

(*Continued from page 39*)

the quick answer would be "Yes." But on sober second thought, the unfeasibility of this idea becomes obvious. We have no metropolis which we can write off in such disruption. It would be out of the question to build a test city just for that purpose. And the risk of "trying it" on slum areas "which ought to be cleaned out anyhow" is unthinkable, considering the menace to the surrounding community area.

Another point is that Britain has the only other major sea arm, so what meaning can there be in naval offensive lessons learned at Bikini, considering the very specific unlikelihood of our warring with England? This time, the premise is readily resolved. We intend to benefit by *defensive* lessons. True, it could now be reiterated how an enemy would, instead, lay assault to our cities. But there is at least this rationalization. From the elementary viewpoint, we wish a test—broadly speaking—against a representative grouping of man-made structures and equipment. With a city target unacceptable at this time, the naval vessels afford us a fitting alternative.

Let us now consider the precise investigations planned at Bikini—and let us say here that these definitely are not slipshod, too hastily arranged, or incomprehensive, as some tend to argue. Six months have been expended in the setup alone. In all, there are nine primary technical staff divisions. Besides (1) the handling of the bomb operations, there are studies of (2) blast, pressure, and shock; (3) wave motion and oceanography; (4) electromagnetic propagation and electronics; (5) radiological safety; (6) radiometry; (7) radiation; also (8) remote measurements; and (9) technical photography.

As for aircraft, they will: (1) Drop the bomb; (2) gather all possible scientific data by means of instruments, photos, and air samples; (3) provide for any necessary air-sea rescues; and (4) afford accommodations for test directors, for scientific observers, and also for press and radio men.

Five B-29 bombing crews have been designated to stand ready, and these are continuing to practice the pattern. At the last minute, one of these teams will "get the nod." This selected crew will initially make three "dry" runs, then plummet the A-bomb on the fourth—or a later run if there is any hitch. An inordinate number of "refusals" will bring postponement of the test to another day. Weather experts have calculated that the Bikini area has seven or eight days in each month which are suitable for Blast Four. East winds would be required up to 30,000 ft. to keep the atomic cloud from jeopardizing the supporting fleet and adjacent islands. Then, too, the weather must be clear enough for bombardier to see the target.

Further notes: In pre-tests, some 30 "pumpkins"—atomic bomb dummies—have been loosed, both on rehearsal targets off the West Coast and, presumably, at Almagordo, and about the same number of sham bombs are being triggered in early trials at Bikini. . . . Expense of the Bikini project has been exaggerated, for 90% of the target ships have been earmarked for scrap. The cost of personnel, instrumentation, the bomb, etc., brings the sum to the neighborhood of the outlay for one modern warship, and this is considered cheap. . . . Exact dimensions of the target pattern is not divulged, but it is known that some 23 vessels will be within a thousand yards of the blast. . . . One report has it that twenty scale-model tests were made, simulating Operation Crossroads with 3¾-lb charges of TNT detonated over 2 ft. models of Victory ships floating in deep water. Reported results: Hatches were disrupted, plates were buckled, the ships were violently gyrated, but none sank. . . . The Bikini test will be run on code time. X is hour of arrival at test stations, H is predicted hour of blast, M is hour of actual blast, and M Plus will denote times of all succeeding studies of air, water, and atoll soil; tracing of the bomb cloud; reading of various instruments; entry into blast zones, and the like. Many of the scientific answers supplied by the test will be available immediately; however, some won't be known for months, others not for years or even in the lifetime of the man concerned.

It has been announced that there will be no overall censorship in relation to Operation Crossroads, but there are these seven specific taboos: (1) Precise horizontal distance of the bomb burst in relation to the target array; (2) exact altitude of explosion; (3) exact bearings of the target vessels in relation to each other and to the pattern; (4) all techniques and equipment in relation to carriage and release of the bomb; (5) exact data concerning pressures, temperatures, and the various other pertinent studies; (6) the degree of efficiency of the bomb itself; and (7) any photos or information which, in themselves or in combine with others, would lead to conclusions on the other six points.

Among phenomena to be checked are effects of explosion on aircraft in flight (the drones), effect on radio waves, and on radar, also blast pressure, infra red rays, photography, and radio activity in the air. And among other measurable elements are heat radiation, light, gamma rays, water waves, shock waves in air and water, and motions of aircraft and of ships as a result of the bomb burst. The following outline supplies further details on the studies:

Instrumentation required to measure air blast, under water pressures, and shock wave velocity, will be primarily concerned with pressure and shock in free air and water (independent of ship structures) as functions of distance and time. Most numerous instruments are ball crusher gages and aluminum foil meters, the former measuring air pressure by the deformation of a soft copper ball by a steel piston in a narrow cylinder, and the latter calculating air pressure by the rupture of aluminum foil. Other instruments will measure underwater pressure time curves, peak pressures, and shock wave velocity.

Ship instrumentation will be concerned with the observing and measuring effects of the blast causing structure damage to the various target vessels and their machinery and equipment. Strain and displacement gages, of many types, will comprise a mechanical linkage system connecting two portions of the ship's structure and equipped with indicating means. A simple device for the measurement of blast effects on the deck of target ships will be empty 5-gal gasoline cans, blast pressure being determined

HANGAR FLYING

LOCKHEED

The Wreckers

If you ever want to tear a wing off an airplane, check with the men in the Structures Lab at Lockheed's Factory B-1 in Burbank. These boys are experts.

Not long ago their entire career consisted of deliberately ruining the meticulously engineered assemblies that went into the *Constellation*, just to see if the parts came up to Lockheed's exacting standards.

For instance: they took up number 61 (the first *Constellation*), blew a hole in one of the two ones on the nose landing gear, and then brought the plane in at 80 mph. The *Constellation* landed nicely.

Another time these testers purposely threw dirt and water into the oil lines of the hydraulic booster system, forcing it to work under what they understate as "adverse conditions." Adverse, that is.

They even kicked around a whole tail control assembly in a chamber that was 70 degrees below zero (Fahrenheit) until all the low-temperature bugs had been licked.

As a result of this kind of highly creative destruction, which goes on at Lockheed year in and year out, the *Constellation* is the most advanced and safest transport in service today.

L to L for L

by the amount of crushing of these cans.

Navy drone aircraft which will fly in the proximity of the blast will be equipped with VGTA (velocity, gravity, time, and altitude) recorders, while AAF drone aircraft will carry television transmitters, recorders, and flight analyzers, all devices to report and record the effect of the detonation wave on the operating characteristics of aircraft. No aircraft which carries personnel will approach nearer than 8 nautical miles to the blast, and it is expected that the bomb-carrying B-29 will have retreated to such a distance after its drop and prior to the detonation. Drone craft, of course, will go directly into the burst-cloud.

In the field of wave motion, supersonic echo soanders will measure the vertical motion of both the target ships and buoys, while pressure recorders on the lagoon bottom will record water depth versus time by measurement of the hydraulic pressure. There will also be extensive aerial and surface photography of the water waves and motion of the target ships under wave action. In addition, seismographs will be set up on the islands to observe the propagation of the shock waves through the earth.

Measurements also include extensive surveys of the atoll and the surrounding regions with regard to effect on physical oceanography, also biology, geology, and fish.

In the sphere of electromagnetic propagation and electronics, studies will be made of the A-bomb effects on the propagation of electromagnetic waves. These tests are planned to show the influence on both ground and sky wave transmission of the intense local ionization resulting from the detonation. Other experiments will show the radar reflective properties of the bomb cloud and the intensity of the atmospheric electrical disturbances developed by the explosion.

Standard radar and sferics (direction finding) equipment, also devices specially constructed for the tests, will be used to measure the electromagnetic propagation. AAF drones will carry Geiger counter warning circuits and transmitters to determine the effect of the bomb explosion on radio propagation in the 5-9 mc. range.

Section on safety involves safeguarding of personnel with respect to radiological hazards to be encountered. This includes measurement of radiological phenomena in areas to be entered by various personnel and for tracking movements of radioactive air and water masses. Primary safety device is the portable Geiger counter, which indicates radioactivity by a clicking sound or the movement of a hand on a dial. The counter consists of two electrodes in a gaseous medium. Passage of an ionizing ray through the counter permits a small current to flow across the electrodes. This current is a measure of the intensity of radiation. Additional safety devices are ionization chambers, specially sensitized films, and chemical capsules which indicate total radioactivity from the measurement of induced radioactivity.

Radiometry concerns measurement of light in the visible spectrum and the adjacent wave bands, such as ultra-violet and infra-red. This is distinguished from calculation of radiation or the measurement of gamma rays, neutrons, etc. Among instruments used here are: Spectographs to obtain spectral distribution of the first flash; photoelectric units to reveal intensity of the first flash as a function of time; and bolometers to measure total radiant energy emitted by the first flash.

As for radiation, findings in this field will not be published, in accordance with current security restrictions. Instruments and techniques used here are also "classified."

Remote measurements will deal with determination of tidal data at Midway, Wake, Kwajalein, and Eniwetok. In addition, shock will be gaged at these islands, and radioactivity will be traced in the whole central Pacific area.

Operation Crossroads will have a technical photography section that involves hundreds of cameras of a wide range of types. Ground and aerial photographs will be made before, during, and after the drops. In addition, motion picture and still cameras will record background material for a complete pictorial record of all phases of the experiment preparations.

Ground photos will be made from fixed installations on 75-ft. steel towers, placed at strategic points on Bikini Atoll. All these cameras will be radio controlled.

In the target pattern, Orbit Points and Reference Points have been set at varying degrees and nautical miles from aiming point, and these will be used to key the precise missions of the aircraft. Here is the complete cheek of the aeronautical operations:

The B-29 command plane, flying at 5,000 ft., will rove approximately 20 nautical miles from the burst. And the B-29 bomb carrier will fly on an axis of 45 deg. toward the target and, at the time of the blast, will have turned to left (approximately 150 deg.) and be headed out from the target.

Two B-29s, operating slightly below bomb carrier and flying in a circle 180 deg. apart, some 10 nautical miles from target, will drop pressure-measuring instruments. Of eight F-13s, four will circle at 26,000 ft., 90 deg. apart, at some 15 mi. distance; other four will be a little higher than bomb plane, with one

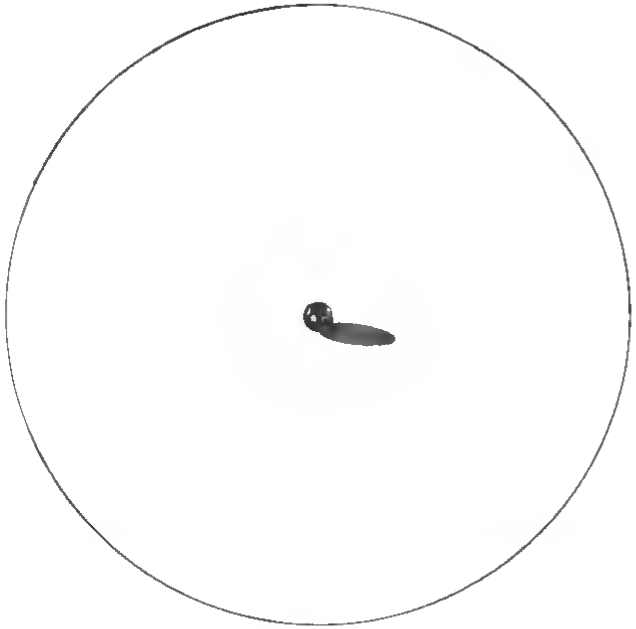
following about 4 mi behind and to left of bombers and turning away at same time Other three head toward blast from 20 mi out, taking their photos.

Of four Boeing B-17 drones, four B-17 control planes, and one B-17 master control craft, one drone will be ready at 24,000 ft, will enter blast cloud, then be picked up by its control plane, which flies around blast clockwise—or by master craft if control doesn't get there in time; and other three drones, at 30,000, 18,000, and 13,000 ft, respectively, will weave similarly through cloud for 30 min Master plane will stand by to aid in control, i.e., 5 mi away at 24,000 ft

Of two Douglas C-54 photo planes, one will take up circle flight at 15 mi distance, then after shock wave will close in to 8 mi Second will operate from a point 7 mi distant. B-29 press photo plane, at 4,000 ft, will circle 20 mi from explosion, and B-29 broadcast plane will be at 8,000 ft, likewise at 20 mi Two other C-54s, carrying official observers, will also fly at the latter altitude and distance. Operating at 25,000 ft, two B-29s and two F-13s will track the movement of the blast cloud over the sea to determine its persistency and radiological activity

Of the four Navy F6F drones, each will be guided by two 2-plane sets of control craft (16 control planes) Initially stationed at 28,000, 20,000, 15,000, and 10,000 ft, respectively, drones will operate through blast cloud in sequence, one control "pitching," other "catching"

There will be three Martin PBMs for emergency air-sea rescue, two at 3,000 ft, third at 7,000. Four F6F photo planes will fly over atoll for verbal "shots" 30 min before blast Two TBM Grumman Avengers will circle at 9,000 and 4,000 ft, 15 mi off, to get flashes. Four TBMs will control boat drones which, about 1 hr after burst, will go into lagoon to test safety of entry. There will also be two HOSs (R-4 Sikorsky Army helicopters) One is slated to pick up dirt samples at Bikini, while other will be stand-by



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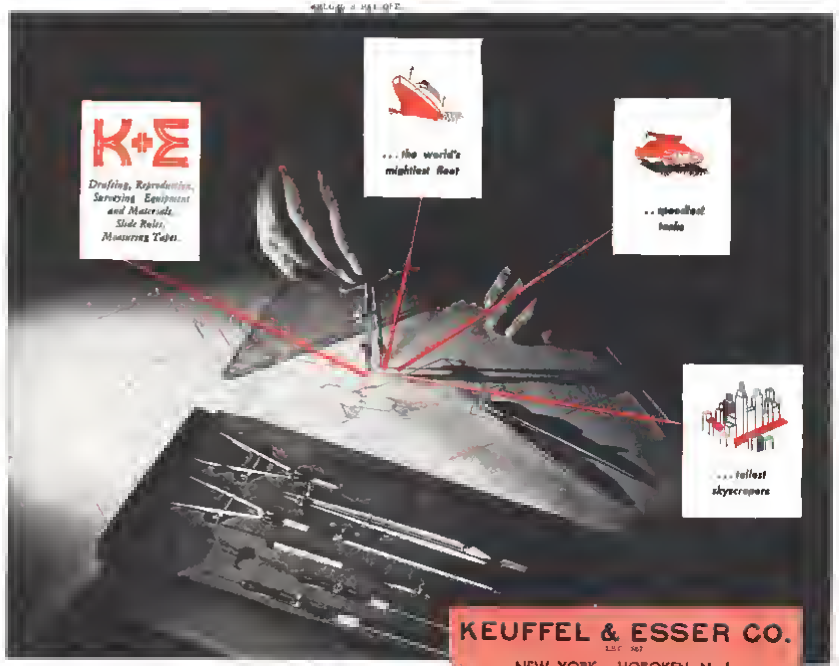

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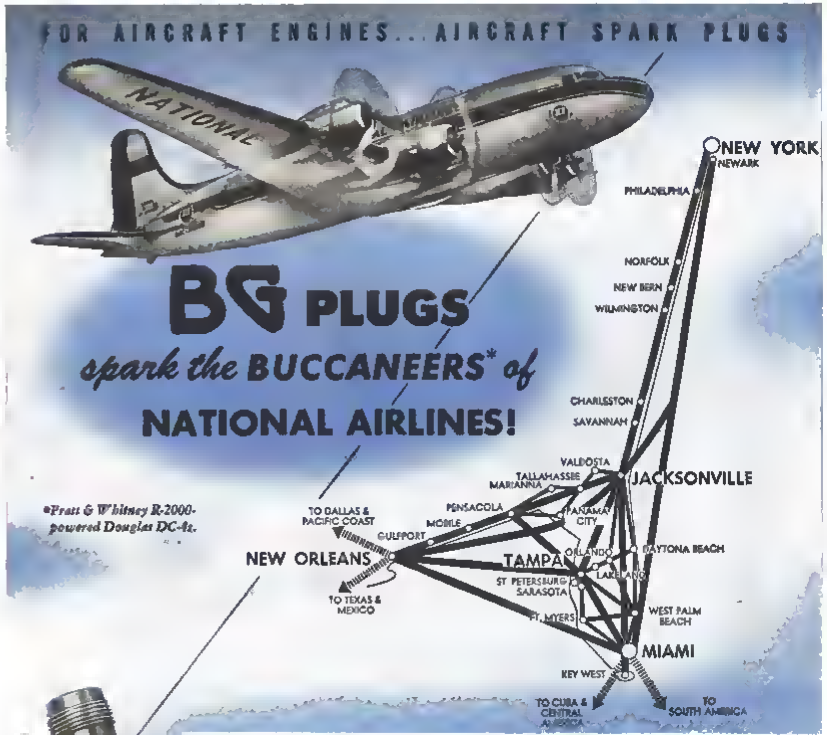

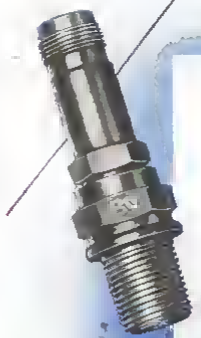

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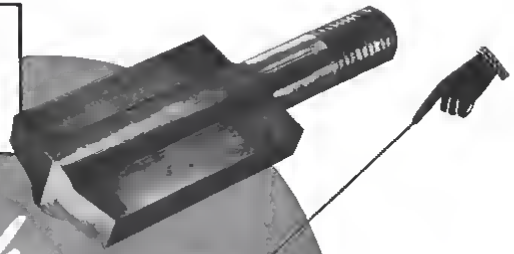
This tool for punching 3/16" thick O H steel sheet was made from a tool steel that promised to provide the *toughness* needed on the job But excessive wear meant that the punch had to be reground after 190 000 holes had been punched



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This punch made from *Stentor* tool steel provided just the right combination of toughness and wear resistance for the job With it, production jumped over 100% —to 387 000 holes between grinds!

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You can do the very same thing, by simply following the steps on the opposite page Carpenter can give you a *definite system* for quickly finding the right tool steel for each job You'll save time and have fewer tools to make And when you put Carpenter's heat treating information to work on your jobs, watch the headaches disappear

To find the road that leads the way to better tools, more output from each machine and press, follow the steps on the opposite page

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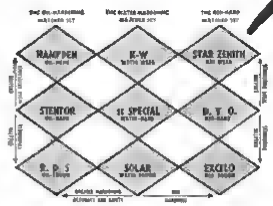
These are really Matched Tool Steels, as one picks up its job where the other "leaves off"

The key steel is the one in the center, No 11 Special, a straight carbon, tough timbre, water-hardening tool steel When you have a tool to make, you first find out if it can be made from No 11 Special If the answer is "Yes", you go no further But when the answer is "No", you use the diagram to point the way to the tool steel that will do the job. For greater wear resistance, you go north For greater hardening accuracy and safety, you move west Just follow the diagram



2 *Ask for a copy of* this Tool Steel Manual

It carries the *Matched Set Diagram* one step further.

In addition to helping you get the most from the diagram, this Manual contains an 80-page *Tool Index and Steel Selector*. Just flick the indexed pages to find the tool steel recommended for any one of more than 200 types of tools! And the *Carpenter Matched Tool Steel Manual* is saving time in heat treating departments, too It gives complete, simplified heat treating instructions that protect the hours of skilled labor that go into tool making

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3 *Make use of* this Tool Steel Experience

In your tool room, heat treating department or production shop—here is another way to help get the most from every pound of tool steel you use.

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Johns-Manville Announces

Fifty Million Dollar Expansion Program

to include World's Largest Research Center for Building Materials, Insulations, Packings, and Asbestos Products

Multi-Million-Dollar "Test Tube" for actual experimental factory production as well as fundamental research, now under construction near Bound Brook, N. J. The Johns-Manville Center ultimately will include six large buildings. Innovations in the first unit include ten experimental factories under one roof, a movable rear wall to permit temporary or permanent additions, or to accommodate extra-large machinery, a special system of interior construction to provide flexibility to meet changing needs for laboratory facilities.

Dr. C. F. Rassweiler, Vice-Pres. of Johns-Manville Corporation in charge of research and development, states:

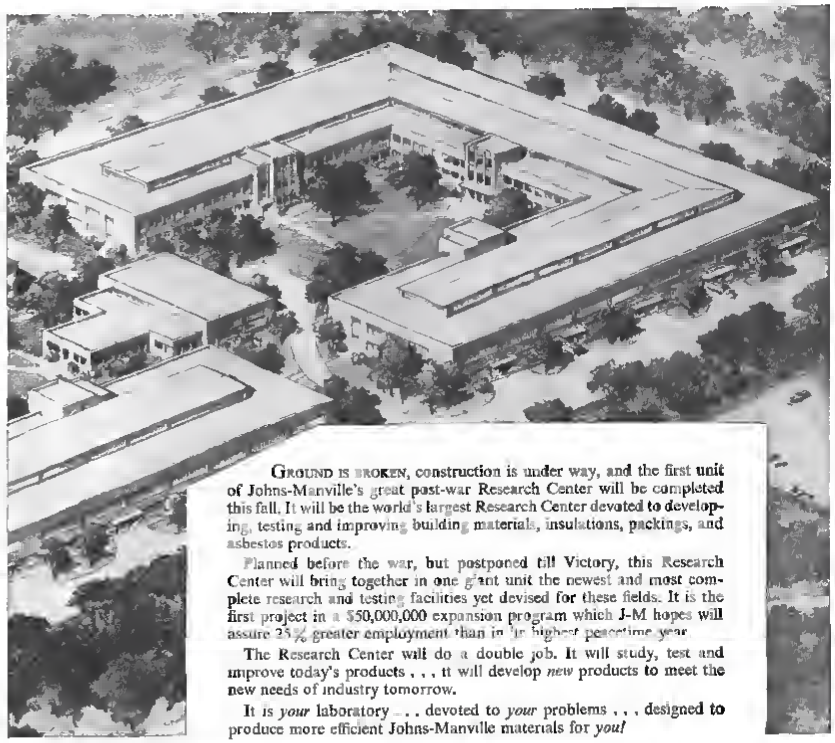
"We are living in an era of scientific improvement unparalleled in man's history. One single development stemming from social and economic needs can bring revolutionary changes throughout an industry. Today, we stand on the threshold of a new era, which has unlimited horizons for the development and improvement of new products for home and industry.

If this goal is to be achieved, some individual or group of individuals must have the imagination, courage and facilities to meet the challenge.

Johns-Manville has accepted this challenge and is now in the process of constructing the world's largest research laboratory devoted to service through science for better homes and greater industrial efficiency.

JOHNS MANVILLE JM PRODUCTS

Johns-Manville



GROUND IS BROKEN, construction is under way, and the first unit of Johns-Manville's great post-war Research Center will be completed this fall. It will be the world's largest Research Center devoted to developing, testing and improving building materials, insulations, packings, and asbestos products.

Planned before the war, but postponed till Victory, this Research Center will bring together in one giant unit the newest and most complete research and testing facilities yet devised for these fields. It is the first project in a $50,000,000 expansion program which J-M hopes will assure 25% greater employment than in its highest peacetime year.

The Research Center will do a double job. It will study, test and improve today's products . . . it will develop *new* products to meet the new needs of industry tomorrow.

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NEW SAFETY LANDING DEVICE

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With the stabilizer, which works manually from the fuselage to the rail, the pilot is able to come in at a steeper angle of approach without danger of stalling and can apply his brakes much more sharply than formerly so as to stop in a considerably shorter run. This permits the pilot to land *where* he wants to, and eliminates the hazard of trees and telegraph lines which usually block emergency landing fields.

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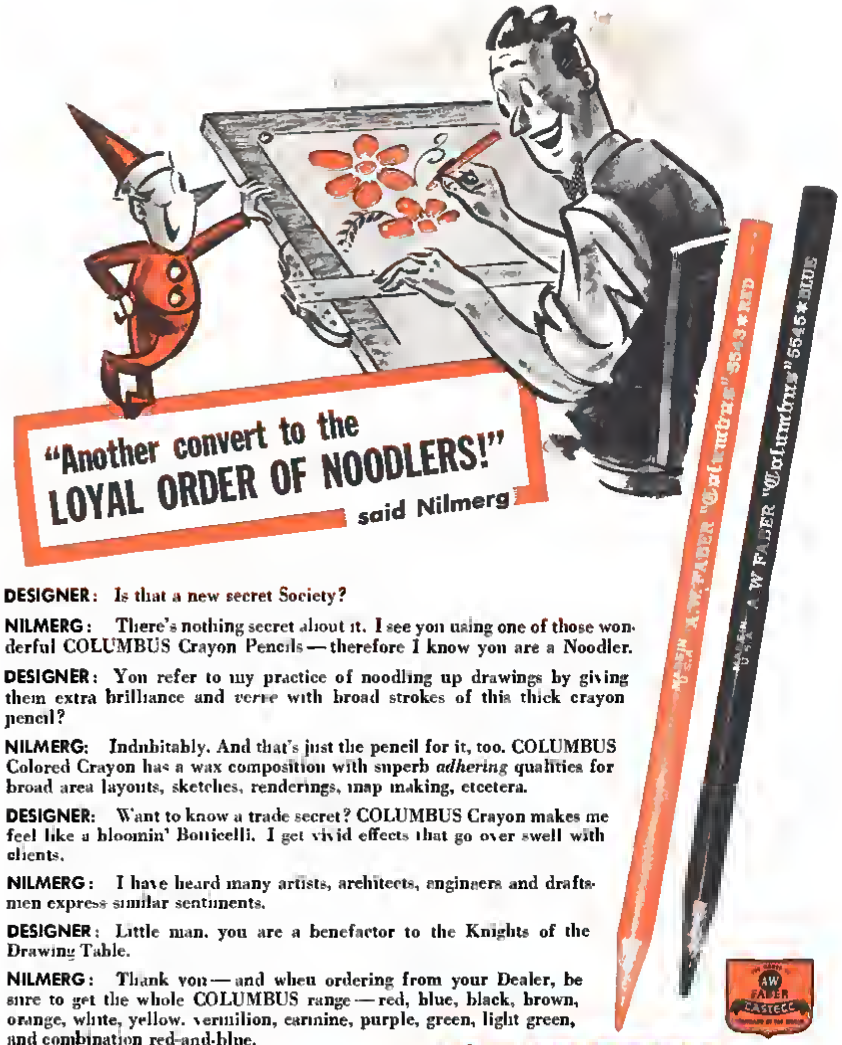

DESIGNER: Is that a new secret Society?

NILMERG: There's nothing secret about it. I see you using one of those wonderful COLUMBUS Crayon Pencils—therefore I know you are a Noodler.

DESIGNER: You refer to my practice of noodling up drawings by giving them extra brilliance and verve with broad strokes of this thick crayon pencil?

NILMERG: Indubitably. And that's just the pencil for it, too. COLUMBUS Colored Crayon has a wax composition with superb *adhering* qualities for broad area layouts, sketches, renderings, map making, etcetera.

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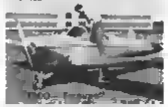

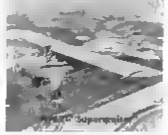

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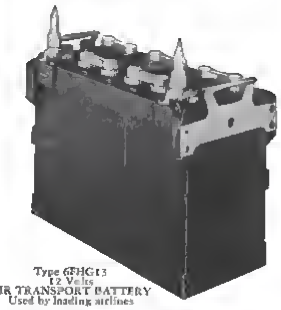

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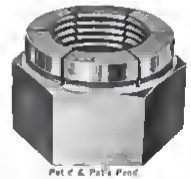

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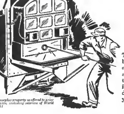

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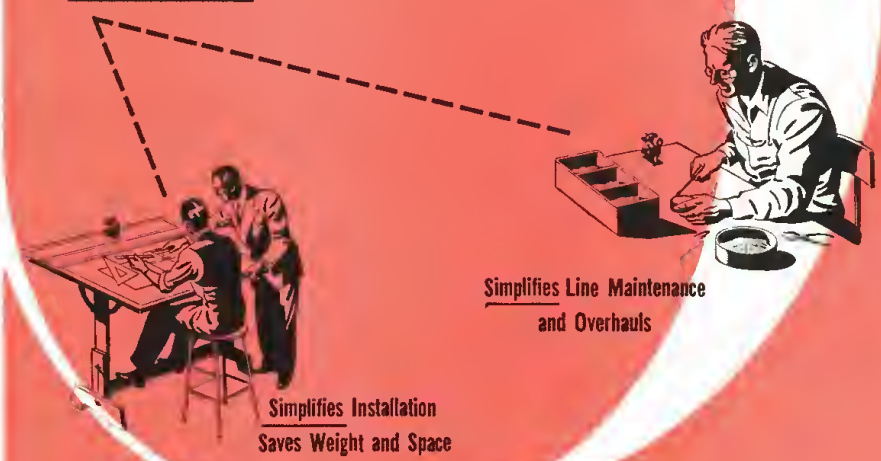

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